UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

REPLY TO THE ATTENTION OF:
DE-9J

April 22, 2003

Mr. Jack Garavanta
Henkel Surface Technologies, Inc.
32100 Stephenson Highway
Madison Heights, MI 48071

Re: **Supplemental Human Health Risk Assessment for Henkel Morenci Site**

Dear Mr. Garavanta:

Enclosed please find a copy of the Human Health Risk Assessment report provided by our consultant, **Techlaw**, Inc. to EPA based on all the historical data provided to the U.S. EPA by Henkel.

If you or your consultant have any technical questions, please contact me at(312) 353-2720. Any legal inquires should be addressed to Andre Daugavietis, Associate Regional Counsel. He is supplying a copy to Mr. Gold under separate cover. His telephone number is (312) 886-6663.

Sincerely,

Brian P. Freeman

Brian P. Freeman
Senior Chemist,
Corrective Action Project Manager

cc: A. Daugavietis, Esq. w/o encl.
R. Budnik, Henkel Corporation, w/encl.
Jeffrey Bolin, Dragun Corporation w/encl.
C. Spencer, MDEQ w/encl

SUPPLEMENTAL RISK ANALYSIS

HENKEL SURFACE TECHNOLOGIES
MORENCI, MICHIGAN
EPA ID No. MID058723867

April 22, 2003

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SUPPLEMENTAL RISK ANALYSIS

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1.0 INTRODUCTION

Henkel Surface Technologies (HST) is a chemical specialty products manufacturer that owns a site that operated in the town of Morenci, Michigan from 1928 until 1988.

An initial risk assessment of the site was conducted by TechLaw in December 2002 using information provided by the U.S. Environmental Protection Agency (U.S. EPA). The initial assessment incorporated only surface soil and groundwater data from sampling events of September 17 and 18, 2002. The intent of this risk assessment was to gather a snapshot of current conditions at the Henkel site, taking into account previous reported remediation work by Henkel. The soil samples from this sampling event were collected to characterize potential impacts to soil in the western portion of the site and between the western property fence line and Bean Creek. Groundwater samples were collected from four existing monitoring wells at the site.

For the initial risk assessment, the Michigan Department of Environmental Quality (MDEQ) Screening Criteria for Residential and Industrial-Commercial (Part 201) were used to evaluate site concentrations and identify potential chemicals of concern (COPCs) (MDEQ 1998a). This approach was conservative in nature. Based upon this screening, COPCs (those chemicals with a maximum detected concentration above the MDEQ Part 201 screening criteria) were identified and quantitative exposures were estimated for the Commercial/Industrial Worker I, Construction Worker, Trespasser, and the Recreational Child and Adult.

Upon receipt of the risk assessment results from the initial assessment in January 2003, representatives from Henkel insisted that all previous site investigation data be included. Therefore, this supplemental risk analysis (SRA) has been performed to amend the initial December 2002 risk assessment. The SRA was conducted to incorporate additional data and to provide an assessment of site conditions incorporating all of the site assessment data provided by Henkel. Major modifications include the use of additional surface soil, subsurface soil, and groundwater report data, evaluation of the site with restricted access and without restricted access, incorporation of administrative controls restricting the use of groundwater, additional hydrogeologic data, use of a 95% Upper Confidence Limit (95% UCL) for comparison of site concentrations to MDEQ Part 201 criteria.for the Industrial/Commercial Worker II.

The initial assessment included evaluation of the adult and child recreationalist. However, due to the lack of data for Bean Creek (sediment and surface water), this pathway was not evaluated in this SRA. For the SRA, a quantitative exposure assessment was performed for the Construction Worker. Groundwater COPCs were trichloroethene (TCE) and vinyl chloride (VC).

Estimates of intake were developed as part of the exposure assessment and were combined with toxicity criteria (e.g., reference doses) to obtain estimates of hazard. The estimates of noncarcinogenic hazard were greater than the target hazard index of one and cancer risks were above 1.0E-05 for the construction worker based upon accidental ingestion of groundwater.

Surface and subsurface soil data associated with Waste Storage Area Number 6 was evaluated separately from all other site-soil data for lead contaminant impacts. The analytical data for soils associated with this area were significantly elevated from the rest of the site data and were considerably higher than the MDEQ screening criteria. **In order to avoid biasing high the exposure point concentration for lead, the data were evaluated separately. It is recommended that additional characterization of soils for Waste Storage Area Number 6 be conducted and it is anticipated that additional remediation may be warranted.**

1.1 Site Background

The Henkel Surface Technologies (HST) site is located in the town of Morenci, in Lewanee County, Michigan. Site property encompasses approximately 10 acres, and is located at the western edge of the City of Morenci. HST owned and operated a facility at the site which produced metal coating compounds for the automotive and other industries. Active operations occurred on this site from 1920's until 1988. The on-site facility manufactured chemical specialty products for metal cleaning and treating, metal drawing compounds, lubricants and rust inhibitors, under several owners and/or names, including Oxy Metal Industries Corporation, Hooker Chemicals and Plastics Corporation, Occidental Chemical, Ford Motor Company, Parker Chemical Company, Parker-Anchem, and Henkel Surface Technologies. Parker Chemical Company was acquired by Henkel Corporation in 1988, and began operating at the Morenci, Michigan location as Henkel Surface Technologies.

The facility was inspected by the Michigan Department of Natural Resources (MDNR) (now known as the MDEQ) on several occasions in 1982. During these inspections, MDNR employees noted chemical residues on the ground and indications of overland runoff from a drum storage area to Bean Creek. There exists file pictures of leaking and overturned drums along the fenceline bordering Bean Creek at the site. Based on file pictorial and analytical information, an administrative order under HST conducted field sampling under an Administrative Order under §3008h of the Resource Conservation and Recovery Act (RCRA) was filed with Henkel Surface Technologies by the US EPA. During the period of 1995 to 2002, samples were selected from locations both on and off the HST site and included local groundwater samples to determine the nature and extent of contamination of hazardous constituents at the HST property.

The existence of groundwater contamination above the U.S. EPA Maximum Contaminant Limits (MCLs) for trichloroethylene and soil contaminated with volatile organic compounds (VOCs), poly-nuclear aromatic compounds (PAHs) and heavy metals (Cr VI, trivalent chromium, lead, zinc, and others) was confirmed during the 2002 sampling event.

1.2 Site Description

The site is bordered on the east and south by commercial/industrial properties, and on the west by Bean Creek. The site lies in a glacial spillway and outwash deposit which can be traced north to Adrian, Michigan and south into Ohio. The flood plain of Bean Creek, on the site's west boundary, has been cut into outwash deposits. The Lewanee County Soil Survey depicts the edge of the flood plain as a scarp running through the site. Subsurface information indicates the presence of a glacial till proceeding to sand and gravel at a depth of approximately 90 feet, under which is an aquifer of major importance to the Morenci area.

The solid waste management units and areas of concern include seven waste storage areas. A site map is provided with the initial December 2002 risk assessment.

1.3 Summary of Modifications and Outcome From the Initial Risk Assessment

The SRA was conducted to incorporate additional data and to provide a more realistic assessment of site conditions. Several major modifications were made to the initial risk assessment as outlined below:

- Additional data were incorporated in to this SRA, including additional surface soil, subsurface soil, and groundwater report data dating back to 1994;
- Evaluation of the site with restricted access and without restricted access;
- Incorporation of administrative controls restricting the use of groundwater;
- Additional hydrogeologic data demonstrating groundwater recharging Bean Creek and Bean Creek as a hydrologic barrier;
- Calculation of a 95% Upper Confidence Limit (95% UCL) and comparison of the minimum of either the UCL or the maximum detected concentration to MDEQ Part 201 criteria;
- Application of the MDEQ Part 201 criteria for the Industrial/Commercial Worker II instead of the Residential/Commercial I criteria;
- Modification of the list of COPCs based upon the use of the 95% UCL and the MDEQ Part 201 criteria for the Industrial/Commercial Worker II;

- Elimination of the drinking water scenario due to above assumptions;
- Evaluation of the trespasser both with administrative controls and without;
- Elimination of the Recreational Adult and Child scenario due to the lack of data on sediments and surface water at Bean Creek; and
- Evaluation of lead-contaminated soils at Waste Storage Area Number 6 separately from other site soil data.

2.0 IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

The initial risk assessment incorporated only data as presented in the *Summary Report: Soil and Groundwater Sampling, Henkel Surface Technologies Facility, Morenci, Michigan Facility MID 058 723 867*, prepared by Dragun Corporation (Dragun) and dated July 18, 2002. In addition to these data, this supplemental risk analysis included surface soil, subsurface soil and groundwater data from the following reports:

- Dragun, *Interim Soil Report - Closure Activities, Parker Amchem, Hazardous Waste Storage Pads, Morenci, Michigan Facility MID 058 723 867*, January 31, 1995;
- Dragun, *Groundwater Investigation Report - Closure Activities, Parker Amchem, Hazardous Waste Storage Pads, Morenci, Michigan Facility MID 058 723 867*, March 27, 1995;
- Dragun, *Soil Characterization Report, Henkel Surface Technologies Facility, Morenci, Michigan Facility MID 058 723 867*, October 22, 1997;
- Dragun, *Groundwater Sampling report, Henkel Surface Technologies Facility, Morenci, Michigan Facility MID 058 723 867*, January 28, 1999;
- Dragun, *Limited Soil removal Report, Henkel Surface Technologies Facility, Morenci, Michigan Facility MID 058 723 867*, February 14, 2002;
- Earth Tech *Hydrogeologic Study and Wellhead Protection Area Delineation, City of Morenci*, July 1997; and
- Memo from Kenneth Gold to Andre Daugavietis, Esp. Re: Henkel Surface Technologies, RCRA (3008h)-05-2002-0004, dated February 21, 2003.

The analytical data as extracted from these reports are summarized by report in Tables 2.1a through 2.1g for surface and subsurface soils and Tables 2.2a through 2.2d for groundwater.

2.1 Analytical Results for Surface Soil

Table 2.5, Occurrence, Distribution, and Selection of Chemicals of Potential Concern, summarizes the available surface soil data. The table lists all chemicals that were detected at least once. The minimum and maximum concentrations, location of the maximum concentration, frequency of detection and the range of detections are also provided. The following organic and inorganic chemicals were detected in surface soil: 1,2,4-trimethylbenzene, acenaphthene, acephthelene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-c,d)pyrene, — and p-xylene, methylene chloride, o-xylene, phenanthrene, pyrene, TCE, total xylene, Cr VI, copper, lead, and zinc.

Where data for total chromium were reported, the concentrations were assumed to be Cr VI. This is in accordance with MDEQ Integrated Table of Part 201 Cleanup Criteria and Screening Levels (MDEQ 1999), which notes that "if analytical data are provided for "total" chromium only, then values for Cr VI must be applied as the cleanup criteria". This was applied to all soil and groundwater data.

The data as listed in Table 2.5 for lead do not include analytical results associated with removal activities at Waste Storage Area Number 6. Verification sample results indicate elevated levels of lead in surface soils associated with this area. The exclusion of this data from the other available site data was done to avoid a high bias of overall site lead levels. The concentration of lead in surface soil associated with Waste Storage Area Number 6 is addressed separately in Section 2.3 of this report.

2.2 Analytical Results for Subsurface Soil

Table 2.6, Occurrence, Distribution, and Selection of Chemicals of Potential Concern, summarizes the available subsurface soil data. The table lists all chemicals that were detected at least once. The minimum and maximum concentrations, location of the maximum concentration, frequency of detection and the range of detections are also provided. The following organic and inorganic chemicals were detected in subsurface soil: methylene chloride, Cr VI, copper, lead and zinc.

Similar to surface soils, the concentration of lead in subsurface soil associated with Waste Storage Area Number 6 is addressed separately in the following section.

2.3 Analytical Results for Lead in Soil at Waste Storage Area Number 6

Remediation of soil at Waste Storage Area Number 6 was conducted to remove lead contaminated soil. Tables 2.1b and 2.1d summarize the results of verification samples for surface soil at Waste Storage Area Number 6. Samples V-1 through V-13 represent pre-remediation concentrations and active-remediation concentrations of lead. Samples V-14 through V-26 are representative of post-excavation concentrations of lead in soil. For purposes of this SRA, it was assumed that only samples V-14 through V-26 are representative of the current levels of lead in soil. Samples were collected at depths of 0-2 feet, 1-2 feet, 2-3 feet, 3-4 feet, 4-5 feet, 5-6 feet, 6-7 feet, and 7-8 feet. Surface soil is assumed to be 0-2 feet, while all samples below 2 feet are assumed to be representative of subsurface soil. There were 18 reported results for surface soil with lead concentrations ranging from 4.8 mg/kg [SB-27 (sample location)] to 56,000 mg/kg (V-17). Six subsurface soil results were reported with concentrations of lead ranging from 2.5 mg/kg (V-24) to 1,200 mg/kg (V-14).

The maximum detection of lead in surface soil at other areas of the Henkel facility was 640 mg/kg (HA-1) and for subsurface soil, 5.5 mg/kg (SB-5). Since the concentrations of lead at Waste Storage Area Number 6 are approximately 87.5 times higher than surface soil concentrations across the site, and approximately 218 times higher for subsurface soil, including the results associated with this area with the other site samples would result in overall concentrations biased high for site surface and subsurface soil and would be overly conservative. Additional sampling is necessary at Waste Storage Area Number 6 to fully delineate the extent of lead contamination and additional remediation of the area is warranted. Exposure to lead-contaminated soil associated with Waste Storage Area Number 6 is addressed in Section 5.2.

2.4 Analytical Results for Groundwater

Table 2.7, Occurrence, Distribution, and Selection of Chemicals of Potential Concern, summarizes the available groundwater data. The table lists all chemicals that were detected at least once. The minimum and maximum concentrations, location of the maximum concentration, frequency of detection and the range of detections are also provided. Concentrations for metals are reported as dissolved metals, for consistency with the MDEQ Part 201 screening criteria. The following organic and inorganic chemicals were detected in groundwater: 1,1-dichloroethane, 1,1-dichloroethene, bromodichloromethane, chloroform, cis-1,2-dichloroethene, trans-1-2-dichloroethene, TCE, trichlorofluoromethane, 1,1,1-trichloroethane, VC, arsenic, total chromium, copper, lead, nickel, and zinc.

Table 2.2c includes analytical results for calcium, potassium, magnesium and sodium. These inorganics are considered essential nutrients by the U.S. EPA and it is generally accepted that contact with groundwater will not results in adverse effects (USEPA 1989). Therefore, calcium, potassium, magnesium and sodium are eliminated from further analysis in this supplemental risk analysis.

2.5 Exposure Point Concentrations

Exposure point concentrations (EPCS) are intended to be a conservative estimate of the average concentrations of chemicals in a specific medium (e.g., either soil or groundwater) to which a receptor (i.e., industrial worker) may be exposed to at a given site. EPC are estimated for surface soil, subsurface soil, and groundwater using the analytical data summarized in Tables 2.1(a-g) and 2.2 (a-d). For chemicals with two or fewer detects, the maximum detected concentration is used at the EPC. For chemicals with greater then two detects, an estimate of the 95-percent upper confidence limit (95% UCL) on the arithmetic mean is calculated. The minimum of either the maximum detected or the 95% UCL was applied as the EPC.

2.5.1 Non-detects

Typically, if either all analytical results are non-detects or less than two samples were detects, non-detected data is not incorporated into the calculation of the EPC. However, for data sets with greater than two detects, a proxy value is assigned to any analytical results within that data set that were reported as below the method detection limit (MDL), for purposes of estimating the EPC. Non-detects may be representative of a concentration that is actually zero or close to zero, or may correspond to a concentration greater than zero, but just below the MDL. U.S. EPA (USEPA 2002) recommends several methods for handling non-detects. The simple substitution method was applied for this analysis. For all data sets with greater than two detects, a proxy value equal to the MDL is applied for non-detects within a data set and used for calculation of the EPC.

2.5.2 Distribution

The most common methods for determining 95% UCLs are distributional methods. These methods rely on a determination of a normally or lognormally distributed data set. Distribution-free or nonparametric tests are available if the distribution of the data set can not be determined.

The Shapiro Wilk W test was used for each data set to determine whether the distribution of the data set could be defined as normal or lognormal. The results of the test were inconclusive, thus no assumptions concerning the distribution of the data sets were made.

2.5.3 95% UCL Calculation

As no assumptions concerning the distribution of the data sets were applied, the 95% UCL was calculated using the one-sided Chebyshev Inequality method. The Chebyshev Inequality method does not rely on a known distribution, is appropriate for small data sets, and can be applied to the sample mean to obtain a distribution-free estimate of the UCL for the population mean (USEPA 2002). Per U.S. EPA guidance, the population mean and standard deviation are estimated using the sample mean and sample standard deviation. The numerical example of the Chebyshev Inequality method as applied for determining the 95% UCLs is shown below.

$$UCL_{1-\alpha} = \overline{X} + \sqrt{\frac{1}{\alpha} - 1}\left(s / \sqrt{n}\right)$$

where:

X	=	arithmetic mean of data;
α	=	confidence coefficient, 0.05 (for 95% confidence);
s	=	Sample standard deviation; and
n	=	number of concentrations (detects and non-detects) in data set.

The results of the 95% UCL calculations are provided in Attachments A.1 (surface soil), A.2 (subsurface soil) and A.3 (groundwater). The minimum of either the maximum detected concentration or the 95% UCL was applied as the EPC. Tables 2.5 through 2.7 list the EPC as the "concentration used for screening".

2.6 Screening Criteria

The MDEQ Part 201 generic screening criteria tables were used as the screening criteria for identification of COPCs (MDEQ 1998a). The Henkel site was assessed to be an industrial/commercial land use site and the MDEQ Part 201 criteria for the Industrial/Commercial II scenario were deemed most appropriate.

Restrictions on use of groundwater were taken into consideration as well as the hydrogeology of the site. Based upon restrictions on groundwater usage, the drinking water pathway (Guidesheet No. 2) was eliminated from consideration for the industrial and trespasser receptors. However, the construction worker could encounter groundwater while digging or trenching and accidentally ingest groundwater. Therefore, the industrial level II, III and IV drinking water criteria were applied for the construction worker and groundwater scenario. Groundwater does recharge Bean Creek, which is considered a surface water body. Therefore, the groundwater/surface water interface protection criteria (Guidesheet No. 12) were included for consideration as potential limiting criteria.

The most conservative and appropriate MDEQ Part 201 screening level was used to screen against the EPC. Table 2.3, Screening Criteria for Constituents Detected in Soil, summarizes the MDEQ Part 201 screening criteria that were used for comparison against surface and subsurface soil EPCS, while Table 2.4, Screening Criteria for Constituents Detected in Groundwater, summarizes the screening criteria for groundwater. These screening criteria are also listed on Tables 2.5, 2.6, and 2.7, Occurrence, Distribution and Selection of Chemicals of Potential Concern, as the "screening toxicity value". It should be noted that the MDEQ Part 201 screening levels for dermal contact screening values incorporate both dermal contact and direct ingestion of contaminants (MDEQ Part 201 Rule 720 R299.5720).

The regulations of MDEQ Part 201 do allow for background metal concentrations to supercede the MDEQ Part 201 screening criteria if the background concentrations are greater than the screening criteria. Some limited data were available for background concentrations of metals, as noted in Table 2.1e, April 1994 Analytical Data Summary for Inorganic Constituents Detected in Background Soils. However, the background data for soil were limited in nature and the EPCS were above background levels. Background data was not available for groundwater. Therefore, the MDEQ Part 201 screening criteria were applied.

2.7 Surface Soil COPCs

Table 2.5, Occurrence, Distribution and Selection of Chemicals of Potential Concern, provides the results of the comparison of the EPCS for surface soil and the associated screening toxicity values. Where the EPC is less than the screening toxicity value, the chemical was eliminated from further consideration and not identified as a COPC. Chemicals were identified as a COPC only if the EPC was greater than its associated screening toxicity criterion. Those chemicals identified as surface soil COPCs are Cr VI, fluoranthene, and xylene.

Only two detects for xylene were noted (57 and 710 ug/L). As such, the maximum detected concentration was used as the EPC. The EPC was only slightly higher than the screening criterion of 700 ug/L. It is noted that this is a conservative approach and uncertainties associated with the xylene EPC are discussed in the Uncertainties section of this report.

As discussed in Section 3.3.2, Trespasser, the evaluation of the trespasser against industrial/commercial COPCs is not the most appropriate. Even though the trespasser is on-site without facility permission, COPCs should be identified using the MDEQ Part 201 residential screening criteria. Applying the EPCS as calculated in this SRA to the MDEQ screening criteria as noted in the initial December 2002 risk assessment, two additional COPCs were identified for the trespasser based upon criteria for direct contact with surface soil: benzo(a)pyrene and dibenzo(a,h)anthracene.

2.8 Subsurface Soil COPCs

Table 2.6, Occurrence, Distribution and Selection of Chemicals of Potential Concern, provides the results of the comparison of the EPCS for subsurface soils and the associated screening toxicity value. Where the EPC is less than the screening toxicity value, the chemical was eliminated from further consideration and not identified as a COPC. Chemicals were identified as a COPC if the EPC was greater than its associated screening toxicity criterion. Only one chemical was identified as a subsurface COPC: Cr VI..

2.9 Groundwater COPCs

Table 2.7, Occurrence, Distribution and Selection of Chemicals of Potential Concern, provides the results of the comparison of the EPCS for groundwater and the associated screening toxicity value. Where the EPC is less than the screening toxicity value, the chemical was eliminated from further consideration and not identified as a COPC. Chemicals were identified as a COPC if the EPC was greater than its associated screening toxicity criterion. TCE and VC were the chemicals identified as a groundwater COPCs.

3.0 EXPOSURE ASSESSMENT

The objective of the exposure assessment is to estimate the type and magnitude of potential exposures to the site COPCs through contact with various media. The results of the exposure assessment are combined with the results from the toxicity assessment (Section 4.0) to characterize potential risks (Section 5.0). According to U.S. EPA (1989), an exposure assessment is a three-step process involving characterization of the exposure setting, identification of exposure pathways, and quantification of exposure. These three steps are completed through 1) finalization of the conceptual site model; 2) estimating the EPCs; 3) determining exposure assumptions; and 4) quantitatively estimating exposure. Estimating EPCs was previously discussed in Sections 2.5 through 2.9.

3.1 Site Conceptual Model

The site conceptual model as described in Section 3.0 of the December 2002 initial risk assessment applies for this SRA. Modifications and/or clarifications to the site conceptual model as presented in the initial risk assessment include the following assumptions:

- Land use is industrial and is assumed to remain zoned for industrial use only;
- The portions of the site where regulated units were operated are currently fenced, limiting access to the site by members of the public;
- The western border and the side by the embankment of Bean Creek do not have restricted access;
- Administrative controls are in place restricting the use of groundwater arising from the site;
- A construction worker could encounter shallow groundwater; and
- Bean Creek is a 100% gaining stream, forming a hydraulic boundary for groundwater coming from the site.

3.2 Potential Receptors

Potential receptors are defined as human and nonhuman organisms (i.e., ecological) that may contact or be exposed to site-related contaminants in environmental media. Current and reasonably anticipated future land use was considered when selecting potential receptors. Potential human receptors at the site include the following:

- Industrial/commercial worker (current and future);
- Trespasser (current and future); and
- Construction worker (current and future).

The industrial/commercial worker was defined as a non-intrusive worker, with limited outdoor exposure to site contaminants. The trespasser was identified as a potential receptor even though some restrictions are in place (e.g., fencing) limiting access on to the site. If access to the site is truly limiting then the trespasser scenario would not require evaluation. However, for conservatism, it was also assumed that the restricted access is not 100% enforceable (e.g., guards and 100% perimeter fencing), thus the adolescent trespasser was assumed to be a plausible scenario. Two scenarios are evaluated for the trespasser: with perimeter restrictions (industrial level COPCs) and without perimeter restriction (residential level COPCs). The construction worker was defined as an intrusive worker involved with on-site construction activities.

In the initial risk assessment, the recreational adult and child were identified as potential receptors. However, based upon the information provided for use in this supplemental risk analysis, there is no evidence of surface runoff from the site towards Bean Creek nor is there any surface water and sediment data from Bean Creek to evaluate these receptors. This is discussed in the Uncertainties section.

3.3 Exposure Pathways

U.S. EPA (1989) defines an exposure pathway as, "The course a chemical or physical agent takes from a source to an exposed organism. An exposure pathway describes a unique mechanism by which an individual or population is exposed to chemicals or physical agents at or originating from a source, an exposure point, and an exposure route. If the exposure point differs from the source, a transport/exposure medium (e.g., air) or media (in cases of intermedia transfer) also is included." Reviewing the potential exposure pathways and linking the sources, location and types of environmental releases with receptor locations and activity patterns is conducted to determine the significant pathways of concern.

Soil represents a transport medium for site-related chemicals through the release mechanisms of tracking, excavation, fugitive dust, volatilization and ingestion. Human receptors may be directly exposure to contaminants in surface or mixed (subsurface) soils via incidental ingestion and/or dermal contact. Receptors may indirectly exposed to contaminants in surface soils via inhalation of dust/volatiles. Human receptors may also be indirectly exposed to subsurface soil contaminants that have leached into underlying shallow groundwater.

The following sections discuss the rationale for selection and exclusion of exposure pathways for each of the identified receptors. This information is summarized in Table 3.1, Selection of Exposure Pathways.

3.3.1 Industrial/Commercial Worker

The industrial/commercial worker may contact surface soil during on-site activities. It is anticipated that the worker could be exposed to site contaminants through ingestion of surface soil, dermal contact with surface soil and direct inhalation fugitive dust. However, EPCs for Cr VI, fluoranthene, and xylene were below the MDEQ Part 201 screening criteria for the dermal contact, direct ingestion and inhalation pathways. The screening criteria for protection of the groundwater surface water interface identified these constituents as COPCs. Therefore, additional evaluation of risks and hazards for the industrial/commercial worker is not warranted.

3.3.2 Trespasser

The trespasser is initially evaluated in this SRA as an adolescent trespasser who may cross into the property via Bean Creek and who may contact surface soil while on-site. It is anticipated that the trespasser could be exposed to site contaminants through ingestion of surface soil, dermal contact with surface soil and direct inhalation fugitive dust. However, EPCs for Cr VI, fluoranthene, and xylene were below the MDEQ Part 201 screening criteria for the dermal contact, direct ingestion and inhalation pathways. The screening criteria for protection of the groundwater surface water interface identified these constituents as COPCs. Therefore, additional evaluation of risks and hazards for the trespasser (industrial) is not warranted.

The trespasser is assumed to be a local resident, and therefore the MDEQ Part 201 residential screening criteria are more appropriate for use in screening COPCs and evaluating potential risks. Comparing the EPCS to MDEQ Part 201 residential screening criteria, two additional COPCs were identified: benzo(a)pyrene and dibenzo(a,h)anthracene. These COPCs were identified based upon the screening criteria for direct contact with soils, at levels of 2,000 ug/kg. Risks resulting from incidental ingestion and dermal contact of these two COPCs was evaluated in the initial December 2002 risk assessment. Results from this assessment are discussed in Section 5.1.3.

Two scenarios for the trespasser were evaluated. One scenario compared COPCs identified using the industrial criteria and the other looked at COPCs identified using residential criteria.

3.3.3 Construction Worker

The construction worker may contact surface soil, subsurface soil and groundwater while performing construction activities on-site. It is anticipated that the construction worker could be exposed to site contaminants through ingestion of surface and subsurface soil, dermal contact with surface and subsurface soil and direct inhalation fugitive dust. However, EPCs for Cr VI, fluoranthene, and xylene were below the MDEQ Part 201 screening criteria for the dermal contact, direct ingestion and inhalation pathways. The screening criteria for protection of the groundwater surface water interface identified these constituents as COPCs. Therefore, additional evaluation of risks and hazards for the construction worker is not warranted for these pathways.

The construction worker could come into contact with groundwater during excavation activities. Exposure may be through inhalation of volatilizing constituents, dermal contact and ingestion. The groundwater EPCs were below the MDEQ screening criteria for dermal contact and inhalation of groundwater and volatilized constituents, and therefore, these pathways are not considered further. It is plausible that a construction worker could encounter groundwater during excavation, as the depth to groundwater is shallow (12 to 25 feet). Therefore, the direct ingestion of groundwater for the construction worker was included as a potential exposure pathway.

3.3.4 Complete Exposure Pathways

Summarizing the information in Table 3.1, Selection of Exposure Pathways, the following lists the pathways for each receptor that will be evaluated in the risk analysis:

- Industrial/Commercial Worker - no further evaluation warranted;
- Trespasser - no further evaluation warranted; and
- Construction worker - ingestion of groundwater.

3.4 Estimating Chemical Intake

Quantification of exposure involves quantifying the magnitude, frequency, and duration of exposure for the receptors and exposure pathways of concern. Methods as outlined by U.S. EPA (1989) were used to estimate intake. Potential exposure via incidental ingestion of groundwater was estimated using the following equation and as listed in Table 3.2, Equation for Incidental Ingestion of Groundwater:

$$Intake = \frac{C_{gw} \times IR_{gw} \times EF \times ED}{BW \times AT}$$

where:

Intake	=	Amount of COPC at the exchange boundary (ug/kg-day);
C_{gw}	=	COPC concentration in soil, EPC (ug/L);
IR_{gw}	=	Soil ingestion rate (L/day);
EF	=	Exposure frequency (days/year);
ED	=	Exposure duration (years);
BW	=	Body weight (kg);
AT_c	=	Averaging time for carcinogens (25,550 days); and
AT_n	=	Averaging time for noncarcinogens (days, 365 days x ED).

Table 3.3, Values Used for Daily Intake Calculations for Groundwater, summarizes the default exposure parameters for estimating intake of groundwater for the construction worker. Some modifications to the default exposure parameters as applied in the initial risk assessment were made for the construction worker. The ingestion rate of groundwater and exposure duration were revised to reflect more realistic (and less conservative) assumptions), based upon professional judgement.

4.0 TOXICITY ASSESSMENT

In order to evaluate the risks/hazards associated with potential exposures to COPCs at the site, the types of health effects that may result from exposure to each COPC and the quantitative relationship between the amount of exposure and the extent of its potential effect must be identified. Per U.S. EPA (1989), the toxicity assessment step includes the identification of appropriate exposure periods (e.g., chronic) and the determination of carcinogenic/noncarcinogenic toxicity factors.

The most recently available toxicity factors was used to calculate the risks/hazards based upon the following hierarchy of sources for toxicity factors:

- U.S. EPA Integrated Risk Information System (IRIS);

- Provisional U.S. EPA National Center for Environmental Assessment (NCEA) Superfund Health Risk Technical Support Center;

- Health Effects Assessment Summary Tables (HEAST); and

- MDEQ, 2000. Toxicological and Chemical-Physical Data. OP Memo #18, Attachment B Tables. June 7, 2000.

EPA provided information related to the National Center for Environmental Assessment (NCEA) provisional toxicity values for TCE. While no modification to the MDEQ Part 201 screening criteria was conducted to reflect this new information, the toxicity NCEA information for TCE was applied in estimating risks.

While many of the COPCs may have oral and inhalation toxicity factors, only the oral toxicity factors for TCE and VC are discussed in the following sections, as the only pathway carried forward for quantification of risk is the ingestion of groundwater.

4.1 Noncarcinogens

Chronic oral reference doses (RfD_o) are used as the primary criteria for evaluating noncarcinogenic effects. Oral toxicity values reflect administered-dose values, which represent concentrations that are protective if that amount is ingested. There are two COPCs carried forward for hazard quantification associated with ingestion of groundwater that have oral noncarcinogenic effects: TCE and VC. The associated RfD_os are presented in Table 4.1, Non-cancer Toxicity Data - Oral.

4.2 Carcinogens

Carcinogens are chemicals considered to lack a threshold of no adverse effects, implying that any level of exposure carries some risk. Oral cancer slope factors (SF_o) are derived to estimate risks resulting from oral exposure (i.e., ingestion). Two of the two COPCs identified, TCE and VC have oral carcinogenic effects that are evaluated due to ingestion of groundwater. Table 4.2, Cancer Toxicity Data - Oral, summarizes the carcinogenic information for the COPCs.

4.3 Lead

Published toxicity criteria (e.g., SFs, RfDs) are not available for lead. U.S. EPA recommends that environmental lead exposures be evaluated using the Integrated Exposure Uptake Biokinetic Model (IEUBK) (USEPA 2001c) for children, and the Adult Lead Model (ALM) (USEPA 1996) for industrial exposures to adult receptors. Both of these guidance documents recommend using the average concentration to evaluate exposure to lead. The average lead concentrations in site soils should be compared to a soil concentration of either 400 mg/kg (residential) or 750 mg/kg (industrial) at which exposure to lead is expected to result in adverse health effects. MDEQ lists a draft value of 900 mg/kg lead for direct contact. For estimating risks to site levels of lead, soil concentrations are compared to the MDEQ draft value of 900 mg/kg for direct contact of soil by an industrial/commercial II worker.

5.0 RISK CHARACTERIZATION

Risk characterization is the final step in the risk assessment process, where the results of the exposure and toxicity assessments are integrated into quantitative or qualitative estimates of potential health risks. Potential noncarcinogenic health effects and carcinogenic health risks are calculated separately.

Potential adverse noncarcinogenic health effects are evaluated using the hazard index (HI). The first step in calculating the HI is to compare the average daily intake doses for each chemical to the appropriate RfD. This comparison is expressed as a hazard quotient (HQ), which is calculated as follows:

$$HQ = \frac{Intake}{RfD_o}$$

where:

Intake	=	Amount of COPC at the exchange boundary (mg/kg-day); and
RfD_o	=	Oral reference dose (mg/kg-day).

A HQ of less than one indicates that the predicted exposure to that chemical should not result in an adverse noncarcinogenic health effect.

To assess the overall potential for noncarcinogenic effects posed by more than exposure route and more than one chemical, the hazard index (HI) approach has been developed by the U.S. EPA (1989). This approach assumes that exposure to multiple chemicals could result in an adverse health effect while acting on the same target organ. The HI is calculated as follows:

$$HI = HQ_1 + HQ_2 + \ldots + HQ_i$$

where:

HQ_i	=	The hazard quotient for the *i*th chemical summed across all relevant exposure routes.

HI values can be derived based upon similar target organs. However, for initial screening, all HQs are summed, regardless of target organ. If the HI exceeds a value of 1.0, then target organ-specific HIs are evaluated.

Cancer risks are estimated by multiplying the average daily intake doses for each chemical by the oral cancer slope factor as follows:

$$Risk = Intake \times SF_o$$

where:

Intake	=	Amount of COPC at the exchange boundary (ug/kg-day); and
SF_o	=	Oral Slope Factor (1/(mg/kg-day)

For Michigan, the acceptable cancer risk level is 1.0E-05. Therefore, estimated risks below this value are assumed to be acceptable, and additional investigation is not warranted.

5.1 Quantifying Hazard Estimates and Risks

5.1.1 Industrial/Commercial Worker

EPCs for Cr VI, fluoranthene and xylene were below the MDEQ Part 201 criteria for inhalation, dermal contact and ingestion of both surface and subsurface soil. Excess hazard and risks to these constituents were not estimated for the industrial/commercial worker.

5.1.2 Construction Worker

EPCs for Cr VI, fluoranthene and xylene were below the MDEQ Part 201 criteria for inhalation, dermal contact and ingestion of both surface and subsurface soil. Excess hazard and risks to these constituents were not estimated for the construction worker.

However, noncarcinogenic and carcinogenic risks associated with exposure to ingestion groundwater were evaluated for the construction worker. Table 5.1, Calculation of Non-cancer Hazards: Construction Worker, presents the intake rates for both COPCs, associated HQ, and overall HI. Two COPCs were evaluated for groundwater: TCE and VC. Both of these COPCs had an individual HQ greater than the target HQ of one and the resultant HI was also greater than the target HI of one. The HQ for TCE was 5.5E+04 and the HQ for VC was 1.2E+04, for an overall hazard index of 6.7E+04.

Cancer risks are presented in Table 5.2, Calculation of Cancer Risks: Construction Worker. Both TCE and VC had associated cancer risks well above the Michigan risk level of 1.0E-05. The cancer risk for TCE was 9.4E-05 and the risk for VC was 3.8E-01, for an overall cancer risk to the construction worker of 3.8E-01.

This hazard and risk is solely based upon ingestion of groundwater by the construction worker.

5.1.3 Trespasser

Under the assumption of site restriction and industrial exposure, EPCs for Cr VI, fluoranthene and xylene were below the MDEQ Part 201 criteria for inhalation, dermal contact and ingestion of both surface and subsurface soil. Excess hazard and risks to these constituents were not estimated for the trespasser (industrial).

For the residential trespasser scenario, in addition to the Cr VI, fluoranthene, and xylene, two additional COPCs were identified: benzo(a)pyrene and dibenzo(a,h)anthracene. Both of these COPCs are exhibit carcinogenic toxicity only. Therefore, these two COPCs do not affect the evaluation of noncarcinogenic hazards discussed above for the industrial scenario. The evaluation of incidental ingestion and dermal contact with benzo(a)pyrene and dibenzo(a,h)anthracene in surface soils were calculated in Attachment A of the initial December 2002 risk assessment. As such, these calculations have not been duplicated in this SRA. Incidental ingestion of benzo(a)pyrene and dibenzo(a,h)anthracene resulted in risks of 3.7E-7 and 1.5 E-7, respectively, for an overall risk of 5.2E-7. For dermal contact, the risks for benzo(a)pyrene and dibenzo(a,h)anthracene were 1.6E-7 and 6.8E-8, respectively, for an overall risk of 2.2E-7. The combined exposure risk for incidental ingestion and dermal contact is 7.4E-7. This risk is below the MDEQ risk level of 1E-5 and below the U.S. EPA risk level of 1E-6. The combined exposure risk is 7.4E-7.

5.2 Lead

The EPC for site concentrations of lead in surface and subsurface soil were compared to the MDEQ Part 201 screening value of 900 mg/kg. As the EPC was below the screening value, lead was not considered a COPC. This applies to the overall site, with the exception of Waste Storage Area Number 6.

Removal activities were conducted in Waste Storage Area Number 6, however, levels of lead in both surface and subsurface soil exceed the MDEQ Part 201 screening value of 900 mg/kg. The exclusion of these samples from the rest of the site was done in order to avoid a high bias of lead concentrations across the site.

The analytical data for lead for Waste Storage Area Number 6 are summarized in Tables 2.1b and 2.1d. For soil 0-2 feet below ground surface (bgs), the range of lead is 4.8 mg/kg to 56,000 mg/kg. Subsurface soil 2-3 feet bgs had a detect of 1,000 mg/kg and soil 3-4 feet had a detect of 1,200 mg/kg.

Additional analysis of the lead concentrations is not warranted at this time, as the soil in this area has lead concentrations that greatly exceed the MDEQ Part 201 lead criterion. The soil associated with Waste Storage Area Number 6 should be treated as a hot spot, and due to the high levels of lead in both surface and subsurface soil, it appears that additional characterization of these soil to fully identify the extent of contamination is warranted. In addition, additional remediation will be required to meet the MDEQ Part 201 lead criterion for industrial levels. Until remediation has been complete, restrictions should be placed in this area limiting access and health and safety measures should be employed to protect workers in the area.

6.0 UNCERTAINTIES

6.1 Data Evaluation and Selection of Contaminants of Potential Concern

The selection of site-related COPCs was based on the results of the sampling and analytical program established at the site. Although problems with the data or sample collection procedures were not identified in available information, factors such as appropriate sample locations, adequate sample quantities, laboratory analyses and data validation can contribute to uncertainty with regard to data, and may contribute to an under- or overestimation of risk and hazard. Where at least three detects for a chemical were reported, the 95% UCL was calculated for use as the EPC. Non-detect data were included in the determination of the 95% UCL by substituting a proxy value equal to the MDL. This assumption is conservative, as actual values may be equal or nearly equal to zero or may have been just below the MDL. This use of the MDL for non-detects provides conservative estimate of the 95% UCL. In addition, determination of the 95% UCL was conducted using the Chebyshev Inequality method. While the Chebyshev Inequality method does not rely on distributional assumptions, the method does assume that the parametric standard deviation of the underlying distribution is known, and using an estimate of the standard deviation can result in an underestimation of the UCL for small sample size (USEPA 2002). Therefore, there is some uncertainty that the 95% UCLs as calculated and applied in the SRA could be underestimated.

The EPC for xylene in surface soil was based on two detections out of sixteen samples, therefore the maximum detected concentration was applied as the EPC. The EPC (710 mg/kg) was slightly above the MDEQ Part 201 screening criterion of 700 mg/kg, rendering xylene a COPC. This is a conservative approach and may have resulted in an overestimation of xylene concentrations in soil, as the true site concentration of xylene is most likely between the average concentration and the maximum.

Table 2.2d provides a summary of groundwater data from "Interoffice Communication of Split Sample Results, from Clay Spencer to Monitoring File Data, MDEQ Environmental Laboratory, September 17, 1998". Some of the data for Cr VI were reported as having a MDL of 50 ug/L. This MDL was considerably higher, about 10-times higher, than other MDLs for other data sets. In determining the 95% UCL for Cr VI for groundwater, non-detects were incorporated using a proxy value equal to the MDL. Applying the MDL of 50 ug/L resulted in a 95% UCL greater than the maximum detected concentration. Therefore, the maximum detected concentration for Cr VI for groundwater was applied. This may have resulted in an overestimation of the actual Cr VI concentrations in groundwater.

6.2 Exposure Assessment

Several areas of uncertainty should be considered with regard to the exposure assessment. Exposure parameters for the trespasser receptors were based on professional judgement, relying on guidance whenever possible. However, assumptions made about trespassing activity may overestimate or underestimate actual activity patterns.

The lack of data for certain media also affects the exposure assessment. Data are not available which measure the potential presence and concentration of constituents in surface water or sediment. It is assumed that recreational receptors may use Bean Creek for fishing and/or wading, and may be exposed to COPCs in the surface water and sediment of Bean Creek. A recent study conducted by Dragun Corporation indicates that groundwater that originates beneath the HST site discharges into Bean Creek. Since COPCs have been detected in groundwater, it is reasonable to assume that these COPCs may be present at some concentration in Bean Creek. In addition, historical investigation reports written by MDEQ personnel note that surface runoff of chemicals into Bean Creek was observed, originating from areas of concern on HST property. Due to the lack of surface water and sediment data, a quantitative analysis of exposure to COPCs in these media was not possible.

Per MDEQ requirements, all data for total chromium was evaluated as Cr VI. As some speciation between Cr III and Cr VI will occur, assuming all chromium data as Cr VI more likely resulted in an overestimation of risks to Cr VI.

Maximum detected concentrations were used as EPC where analytical results reported two or fewer detects. Since it is unlikely that receptors will consistently be exposed to the maximum detected concentrations of COPCs, use of these values as EPC is likely to overestimate actual exposure of all receptors to COPCs. For example, xylenes were detected twice in soil, with a maximum concentration of 710 ug/kg. This concentration was slightly above the MDEQ screening criterion of 700 ug/kg. The realistic risk would most likely fall between the mean concentration and the maximum concentration.

The trespasser was originally evaluated using COPCs identified using the MDEQ Part 201 criteria for the industrial/commercial worker II scenario. However, it is typically more appropriate to use residential screening criteria for this receptor. Therefore, risks and hazards using COPCs identified using both criteria were evaluated. If perimeter restrictions are in-place and 100% enforceable, then the trespasser scenario does not require evaluation. However, as few facilities can enforce a 100% restriction of site access, for conservatism, the trespasser was evaluated.

Only exposure to human receptors were evaluated. The assessment does not address any ecological receptors. Additional data would be required to conduct a Tier 1 screening level ecological assessment. Additional data would include: identification of potential receptors, surface water data for Bean Creek and sediment data for Bean Creek.

6.3 Toxicity Assessment

Uncertainties associated with toxicity stem from the integration of the probability of adverse effects in a human population that is highly variable with respect to genetic, age, activity, and lifestyle.

Provisional toxicity values for TCE (NCEA 2001) were applied in estimating hazards and risks. EPA has not formally published these new toxicity factors in either IRIS or the Federal Register. However, the use of these values represents best available science. While it is anticipated that the TCE toxicity factors will be accepted, there is some uncertainty with their until such time.

6.4 Uncertainty Associated with Risk Characterization

The lesser of the 95% UCL and the maximum detected concentration chemicals were compared to MDEQ Part 201 Screening Criteria for the Industrial/Commercial Worker II. Chemicals were initially screened against the most conservative screening criteria for soil or groundwater, and if the EPC exceeded any of the screening criteria, that chemical was considered to be a contaminant of potential concern (COPC). During the exposure assessment, EPCS for COPCs were compared to pathway-specific Part 201 Screening Criteria to determine whether the potential effects of a COPC should be quantitatively evaluated for a potential exposure pathway.

The use of the MDEQ Part 201 Screening Criteria relies on a compartmentalized assessment approach which allows for the identification of COPCs based on comparison to individual pathway-specific levels (for example, a single residential soil criterion based on dermal contact). The overall risks subsequently estimated using the MDEQ criteria consider only those pathways initially identified as posing potentially significant risk. In contrast, typical U.S. EPA screening criteria are based on a spectrum of exposure pathways. For example, screening criteria for residential soils is reflective of soil ingestion, dermal contact, and inhalation of airborne particulates/volatiles. In addition, once COPCs are selected using U.S. EPA screening criteria, the risks subsequently estimated following U.S. EPA's combined cumulative approach consider all complete exposure pathways. In spite of this fundamental difference, it is likely that those contaminants which contribute most significantly to the overall estimates of risk and hazard (risk drivers) in the risk assessment itself have been identified as site COPCs using the MDEQ Part 201 Screening Criteria approach.

7.0 SUMMARY AND CONCLUSIONS

Site EPCS were compared to the MDEQ Part 201 screening criteria for the industrial/commercial worker II. Chemicals with EPCS greater than their associated screening criterion were selected as COPCs and evaluated further. Three COPCs were identified for industrial surface soil: Cr VI, fluoranthene, and xylene. One chemical was selected as a COPC for subsurface soil: Cr VI, and two COPCs were identified for groundwater: TCE and VC. For the trespasser residential scenario, five surface soil COPCs were identified: Cr VI, fluoranthene, xylene, benzo(a)pyrene, and dibenzo(a,h)anthracene.

Comparison of COPC EPCs to the dermal contact/direct ingestion and inhlation MDEQ screening criteria for soil indicated that all EPCs were within acceptable limits and additional analysis was not warranted. Thus, quantitative exposure assessments were not performed for the industrial/commercial worker, construction worker and trespasser (industrial). The construction worker was evaluated for incidental ingestion of groundwater.

Estimates of intake developed during the exposure assessment were modified with associated toxicity criteria to obtain estimates of hazard. Both of the COPCs had associated noncarninorgenic and cancer risk toxicity data for ingestion. Estimates of noncarcinogenic hazard greatly exceeded the target hazard index of one, and cancer risk greatly exceeded the 1.0E-05 risk level for both TCE and VC in groundwater.

As previously noted, soil associated with Waste Storage Area Number 6 was identified as a hot spot and therefore addressed separately from the other site soil. Both surface and subsurface soil at this area exhibit lead concentrations in excess of both the MDEQ draft screening criterion of 900 mg/kg for the industrial/commercial worker II . It is recommended that additional characterization of soil at Waste Storage Area Number 6 be conducted to delineate to full nature and extent of lead contamination in soil. It is anticipated that additional remediation may be warranted.

Limited data were available for soil outside of the site and no data were available for surface water and sediments of Bean Creek. This is a data gap and additional characterization is warranted. It is suggested that sediments and surface water samples be collected and the evaluation of a child and adult recreationist who could potentially contact these media be evaluated. Additionally, data on sediments and surface water for Bean Creek, information on potential ecological receptors in the vicinity of the site, and the potential for the site to serve as ecological habitat is necessary to evaluate the potential for ecological impacts at the Henkel site.

Groundwater was eliminated from direct evaluation as restrictions are in place to prevent the use of groundwater. However, groundwater exists at shallow levels, 10 to 25 feet below ground surface. As such, it is plausible that future construction activities could result in a construction worker being exposed to this shallow groundwater. While use of groundwater fro drinking water purposes was not evaluated, accidental ingestion of groundwater by a construction worker was evaluated. Based upon this analysis, as well the groundwater data, groundwater has been shown to be impacted by site activities above acceptable health levels. In addition to deed restrictions regarding use of groundwater for drinking water and other industrial use, it is recommended that restrictions are placed limited subsurface work that could reach the shallow groundwater.

Based upon the results of the initial December 2002 risk assessment and this SRA, it appears that additional characterization of the site is necessary to fully evaluate potential risks. No data is available to evaluate the sediments and surface water of Bean Creek. Studies indicate that groundwater recharges 100% into Bean Creek and groundwater data indicate that there is contamination due to site activities. While mixing of groundwater and surface water will occur, there is a potential for site contamination in the sediments and surface water of Bean Creek. In addition, while under current conditions the site indicates that there is no surface runoff from the site into Bean Creek, this does not establish that no surface run off has ever occurred. The nature and extent of sediment and surface water contamination must be delineated. This should also include establishing background concentrations for both sediments and surface water. In addition, additional characterization of soil just outside the site fence line is necessary to determine if surface runoff has occurred over time and to what extent site contamination may have migrated off-site.

For purposes of providing risk management, the following presents a summary of the above discussed conclusions:

- Waste Storage Area 6 has lead contamination that greatly exceeds that MDEQ Part 201 industrial II draft screening criterion. Additional characterization of the area is needed. Remediation will be required;

- There is groundwater contamination. While deed restrictions limit the use of groundwater, additional restrictions must be in place to limit construction activities to prevent any accidental ingestion of groundwater by a construction worker. This also relates to any utility worker requiring subsurface access;

- No data is available concerning potential contamination of sediments and surface water in Bean Creek. Characterization of these media is required to complete the evaluation of risk. As the groundwater will mix with surface water, consideration will need to be given for mixing;

- Background soil data is limited and not useful. As such, all contamination is assumed to be due to site activities;

- No background groundwater data is available and limited data on hydrology and hydrogeology of the site is available. Additional characterization hydrologic and hydrogeologic data must be provided;

- The comparison to MDEQ Part 201 screening criteria does not account for cumulative effects across exposure pathways for each receptor. Additional evaluation of overall or cumulative hazards and risks may be warranted;

- There does not appear to be data across the entire Henkel site. For example, only select data associated with former hazardous waste Areas 1 through 7. The reports available do not discuss other activities at the site and whether there is potential for contamination outside of these limited areas; and

- Ecological risks have not been evaluated. It is anticipated that exposure to contaminants in sediments and surface water of Bean Creek will drive ecological risks.

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TABLES

TABLE 2.1a

SEPTEMBER 17 AND 18, 2002
HENKEL SURFACE TECHNOLOGIES

Parameter	CAS #	Units	HA-1	HA-2	HA-3	HA-4	HA-5	HA-6	HA-7	HA-8	HA-9	HA-10	HA-11	HA-12	HA-13	HA-14	HA-15	HA-16	Min. Detect	Max. Detect
1,1,1,2-Tetrachloroethane	63-02-06	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0
1,1,1-Trichloroethane	71-55-6	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0
1,1,2,2-Tetrachloroethane	79-34-5	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0
1,1,2-Trichloroethane	79-00-5	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0
1,1-Dichloroethane	75-34-3	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0
1,1-Dichloroethene	75-35-4	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0
1,1-Dichloropropene	563-58-6	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0
1,2,3-Trichlorobenzene	87-61-6	mg/kg	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0	0
1,2,3-Trichloropropane	96-18-4	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0
1,2,4-Trichlorobenzene	120-82-1	mg/kg	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0	0
1,2,4-Trimethylbenzene	95-63-6	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1	0.1
1,2-Dibromo-3-chloropropane	96-12-8	mg/kg	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0	0
1,2-Dichlorobenzene	95-50-1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0
1,2-Dichloroethane	107-06-2	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0
1,2-Dichloropropane	78-87-5	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0
1,3,5-Trimethylbenzene	108-67-8	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0
1,3-Dichlorobenzene	54-17-31	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0
1,3-Dichloropropane	142-28-9	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0
1,4-Dichlorobenzene	106-46-7	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0
2,2-Dichloropropane	594-20-7	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0
2-Chlorotoluene	95-49-8	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0
4-Chlorotoluene	95-49-8	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0
Acenaphthene	83-32-9	mg/kg	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	0.45	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	0.45	0.45
Acenphthylene	208-96-8	mg/kg	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	0.57	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	0.57	0.57
Anthracene	120-12-7	mg/kg	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	2	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	2	2
Benzene	71-43-2	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0
Benzo(a)anthracene	56-55-3	mg/kg	0.35	<0.33	<0.33	0.77	<0.33	<0.33	<0.33	<0.33	0.49	6.8	0.5	<0.33	<0.33	<0.33	<0.33	<0.33	0.35	6.8
Benzo(a)pyrene	50-32-8	mg/kg	<0.33	<0.33	<0.33	0.87	<0.33	<0.33	<0.33	<0.33	0.67	5.1	0.85	<0.33	<0.33	<0.33	<0.33	<0.33	0.67	6.1
Benzo(b)fluoranthene	205-99-2	mg/kg	0.42	<0.33	<0.33	0.91	<0.33	0.72	<0.33	<0.33	1.2	9.6	0.54	<0.33	<0.33	0.48	<0.33	<0.33	0.42	9.6
Benzo(g,h,i)perylene	191-24-2	mg/kg	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	0.73	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	0.73	0.73
Benzo(k)fluoranthene	207-08-9	mg/kg	0.36	<0.33	<0.33	1.2	<0.33	0.69	<0.33	<0.33	0.06	0.1	0.05	<0.33	<0.33	<0.33	<0.33	<0.33	0.05	1.2
Bromobenzene	108-86-1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0
Bromochloromethane	74-97-5	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0
Bromodichloromethane	75-27-4	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0
Bromoform	75-25-2	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0
Bromomethane	74-83-9	mg/kg	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0	0
Carbon tetrachloride	56-23-5	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0
Chlorobenzene	108-90-7	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0
Chloroethane	75-00-3	mg/kg	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0	0
Chloroform	67-66-3	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0

TABLE 2.1a

SEPTEMBER 17 AND 18, 2002
HENKEL SURFACE TECHNOLOGIES

Parameter	CAS #	Units	HA-1	HA-2	HA-3	HA-4	HA-5	HA-6	HA-7	HA-8	HA-9	HA-10	HA-11	HA-12	HA-13	HA-14	HA-15	HA-16	Min. Detect	Max. Detect
Chloromethane	74-87-3	mg/kg	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0	0
Chromium (VI)	1854-02-99	mg/kg	<0.237	<0.219	<0.217	<0.227	<0.214	<0.230	1.48	<0.231	<0.228	<0.223	1.45	1.74	<.0227	4.9	<0.223	<0.21	1.45	4.9
Chromium (total)	1854-02-99	mg/kg	56.5	29.4	5.2	20	27.6	42	101	12.9	34.9	37.1	36.5	102	18.7	231	15.6	5.6	5.2	231
Chrysene	218-01-9	mg/kg	0.41	<0.33	<0.33	0.69	<0.33	0.4	<0.33	<0.33	0.51	4.9	0.55	<0.33	<0.33	<0.33	<0.33	<0.33	0.4	4.9
Cis-1,2-Dichloroethene	156-59-2	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0
Cis-1,3-Dichloropropene	54-27-56	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0
Copper	744-05-08	mg/kg	36.1	22	<5	64.8	33	308	14.3	8.4	25.2	24.9	18.4	27.1	10.6	64.8	33.4	5.3	5.3	308
Dibenzo(a,h)anthracene	53-73-3	mg/kg	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	2.5	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	2.5	2.5
Dibromochloromethane	124-48-1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0
Dibromomethane	74-95-3	mg/kg	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0	0
Dichlorodifluoromethane	75-71-8	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0
Ethylbenzene	100-41-4	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0
Ethylene dibromide	106-94-4	mg/kg	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0	0
Fluoranthene	206-44-0	mg/kg	1.2	<0.33	<0.33	2.5	0.4	1.2	<0.33	<0.33	1.2	17	1.2	<0.33	<0.33	0.34	0.38	<0.33	0.34	17
Fluorene	96-73-7	mg/kg	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	1.2	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	1.2	1.2
Hexachlorobutadiene	87-68-3	mg/kg	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0	0
Indeno(1,2,3-c,d)pyrene	193-39-5	mg/kg	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	2	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	2	2
Isopropylbenzene	98-82-8	mg/kg	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0	0
Lead	743-99-21	mg/kg	640	25.7	<25	87.1	28.7	99.9	10.7	26.1	40.3	183	63.5	324	12.5	246	34.3	<25	10.7	640
M-and/or p-xylene	133-02-07	mg/kg	<0.1	<0.1	<0.1	<0.1	0.52	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.52	0.52
Methylene chloride	75-09-2	mg/kg	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0	0
N-Butylbenzene	104-51-8	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0
N-Propylbenzene	103-65-1	mg/kg	<0.1	<0.05	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0
Naphthalene	91-20-3	mg/kg	<0.33	<0.33	<0.25	<0.25	<0.33	<0.33	<0.25	<0.25	<0.25	<0.33	<0.33	<0.25	<0.25	<0.33	<0.33	<0.33	0	0
O-Xylene	133-02-07	mg/kg	<0.05	<0.05	<0.05	<0.05	0.19	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.057	<0.05	<0.05	<0.05	<0.05	0.057	0.19
PCB Aroclor 1016	133-63-63	mg/kg	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	0	0
PCB Aroclor 1221	133-63-63	mg/kg	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	0	0
PCB Aroclor 1232	133-63-63	mg/kg	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	0	0
PCB Aroclor 1242	133-63-63	mg/kg	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	0	0
PCB Aroclor 1248	133-63-63	mg/kg	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	0	0
PCB Aroclor 1254	133-63-63	mg/kg	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	0	0
PCB Aroclor 1260	133-63-63	mg/kg	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	<0.33	0	0
P-Isopropyltoluene	99-87-6B	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0
Phenanthrene	85-01-8	mg/kg	0.52	<0.33	<0.33	1.6	<0.33	0.55	<0.33	<0.33	0.34	8.7	0.35	<0.33	<0.33	<0.33	<0.33	<0.33	0.34	8.7
Pyrene	129-00-0	mg/kg	0.68	<0.33	<0.33	1.3	<0.33	0.54	<0.33	<0.33	0.8	15	1.2	<0.33	<0.33	<0.33	0.34	<0.33	0.34	15
Sec-Butylbenzene	135-59-8	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0
Styrene	100-42-5	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0
Tert-Butylbenzene	98-06-6	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0
Tetrachloroethene	127-18-4	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0
Toluene	108-88-3	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0

TABLE 2.1a

SEPTEMBER 17 AND 18, 2002

HENKEL SURFACE TECHNOLOGIES

Parameter	CAS #	Units	HA-1	HA-2	HA-3	HA-4	HA-5	HA-6	HA-7	HA-8	HA-9	HA-10	HA-11	HA-12	HA-13	HA-14	HA-15	HA-16	Min. Detect	Max. Detect
Trans-1,2-Dichloroethene	156-60-5	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0
Trans-1,3-Dichloropropene	54-27-56	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0	0
Trichloroethene	79-01-6	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.1	<0.05	<0.05	<0.05	<0.05	0.1	0.1
Trichlorofluoromethane	75-69-4	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0
Vinyl chloride	75-01-4	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0
Xylenes	133-02-07	mg/kg	<0.15	<0.15	<0.15	<0.15	0.71	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	0.057	<0.15	<0.15	<0.15	<0.15	0.057	0.71
Zinc	744-06-66	mg/kg	638	342	23.9	752	366	703	144	122	325	569	504	2584	69.8	1876	378	34.9	23.9	2584

Notes:

Source: Su··ary Report: Soil and Groundwater Sampling, Henkel Surface Technologies Facility, Dragun Corporation, October 2002 and Central Regional Laboratory (CRL) Form 1 Data sheets

TABLE 2.1b

ANALYTICAL DATA SUMMARY FOR VERFICIATION SOIL SAMPLES: LEAD

WASTE STORAGE AREA NUMBER 6

HENKEL SURFACE TECHNOLOGIES

Depth (ft bgs)	V-1	V-2	V-3	V-4	V-5	V-6	V-7	V-8	V-9	V-10	V-11	V-12	V-13
0-1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	46	140	1100	680	2100
1-2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.3	5.9	4.7	270	550
2-3	46	12	3.8	4.5	2.6	5.6	4.2	2.2	2.8	3	3.5	4.2	21
3-4	5.2	5.2	4.4	3.1	2.3	1.7	N/A	N/A	N/A	3.2	3.3	3.6	62
4-5	2.3	3.6	5.3	3.1	N/A	4.8	1.6	1.4	2.4	4.2	2.9	3.3	450
5-6	1.8	3.1	3.6	1.7	N/A	N/A	1.3	3.4	5	4.5	2.1	2.4	N/A
6-7	1.9	2	2.8	2.8	1.3	7.2	1.6	1.6	4.5	2	2.9	1.7	N/A
7-8	N/A	N/A	2.2	N/A	3.3	2.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Depth (ft bgs)	V-14	V-15	V-16	V-17	V-18	V-19	V-20	V-21	V-22	V-23	V-24	V-25	V-26
0-1	180	410	420	56000	600 (a)	1000	1300 (b)	330	620	N/A	N/A	440	150
1-2	4600	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2-3	1100	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.5 (d)	N/A	N/A
3-4	1200	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.4 (c)	N/A	N/A	N/A
4-5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5-6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6-7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7-8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Notes:

Samples V-1 through V-13 represent pre-excavation samples; samples V-14 thorugh V-26 are represetnative of post-excavation concentrations. Only samples V-14 through V-26 were included for risk assessment purposes.

All concentrations in units of mg/Kg

MDL for all samples: 1 mg/Kg

Source for data: Limited Soil Removal Report Henkel Surface Technologies Facility, Morenci, Michigan, Dragun Corporation, February 14, 2000

a - sample collected at 3 feet bgs

b - sample collected at 2.5 feet bgs

c - sample collected at 3 feet bgs

d - sample collected at 2 feet bgs

TABLE 2.1c

1997 ANALYTICAL DATA SUMMARY FOR INORGANIC CONSTITUENTS DETECTED IN SOIL BORINGS

HENKEL SURFACE TECHNOLOGIES

Parameter	CAS #	MDL	Units	SB-4	SB-6	SB-8	SB-18	SB-21
Hexavalent Chromium	18540-29-9	0.2	mg/kg	N/A	N/A	**14**	N/A	**31**
Lead	7439-92-1	1	mg/kg	**60**	**34**	N/A	**71**	**46**

Parameter	CAS #	MDL	Units	SB-23	SB-24	SB-25	SB-26	SB-30
Hexavalent Chromium	18540-29-9	0.2	mg/kg	**340**	**110**	**390**	N/A	N/A
Lead	7439-92-1	1	mg/kg	**2400**	**1000**	**500**	**560**	**82**

Notes:

N/A: Not analyzed

Depth of all samples, 0-2 feet except SB4, 0-1.5 feet

TABLE 2.1d

ANALYTICAL DATA SUMMARY FOR SOIL BORINGS: LEAD

WASTE STORAGE AREA NUMBER 6

HENKEL SURFACE TECHNOLOGIES

Depth (ft bgs)	SB-24 (1994)	SB-24 (1998)	SB-25 (1994)	SB-25 (1998)	SB-26 (1994)	SB-26 (1998)	SB-27 (1994)	SB-28 (1994)
0-2	N/A	N/A	**130**	**500**	**6.3**	**560**	**4.8**	**6.3**
2	**270**	**1000**	N/A	N/A	N/A	N/A	N/A	N/A

Notes:

All concentrations in units of mg/Kg

MDL not reported in source report

Source for data: Limited Soil Removal Report Henkel Surface Technologies Facility, Morenci, Michigan, Dragun Corporation, February 14, 2000

Soil borings from 1994 and 1998.

TABLE 2.1e

1994 ANALYTICAL DATA SUMMARY FOR ORGANIC CONSTITUENTS DETECTED IN SOIL BORINGS

HENKEL SURFACE TECHNOLOGIES

Parameter	CAS #	Date Sampled	SB-1 (0-2ft)	SB-1 (2-4 ft)	SB-2 (0-2ft)	SB-2 (2-4 ft)	SB-3 (0-2ft)	SB-3 (2-4 ft)	SB-4 (0-2ft)	SB-4 (2-4 ft)	SB-5 (0-2ft)	SB-5 (2-4 ft)	SB-6 (0-2ft)	SB-6 (2-4 ft)	SB-7 (0-2ft)	Min. Detected	Max. Detected
Chloroethane	75-00-3	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
1,1-Dichloroethane	75-34-3	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
1,1-Dichloroethene	75-35-4	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
Trans-1,2-Dichloroethene	156-60-5	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
Methylene chloride	75-09-2	April-94	64	47	<10	28	74	64	<10	38	48	64	<10	<10	200	28	200
1,1,1-Trichloroethane	71-55-6	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
Trichloroethene	79-01-6	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
Vinyl :hloride	75-01-4	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0

Parameter	CAS #	Date Sampled	SB-8 (0-2ft)	SB-8 (2-4 ft)	SB-9 (0-2ft)	SB-9(2-4 ft)	SB-10 (0-2ft)	SB-10 (2-4 ft)	SB-11 (0-2ft)	SB-12 (0-2ft)	SB-13 (0-2ft)	SB-14 (0-2ft)	SB-15 (0-2ft)	SB-16 (0-2ft)	SB-17 (0-2ft)		
Chloroethane	75-00-3	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
1,1-Dichloroethane	75-34-3	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
1,1-Dichloroethene	75-35-4	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
Trans-1,2-Dichloroethene	156-60-5	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
Methylene chloride	75-09-2	April-94	58	62	83	59	28	56	42	200	<10	140	<10	62	91	28	200
1,1,1-Trichloroethane	71-55-6	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
Trichloroethene	79-01-6	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
Vinyl chloride	75-01-4	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0

Parameter	CAS #	Date Sampled	SB-18 (0-2ft)	SB-19 (0-2 ft)	SB-19 (2-4ft)	SB-20 (0-2ft)	SB-20 (2-4 ft)	SB-21 (0-2ft)	SB-21 (2-4 ft)	SB-22 (0-2ft)	SB-22 (2-4 ft)	SB-23 (0-2ft)	SB-23 (2-4 ft)	SB-23 (6-8 ft)	SB-24 (0-2ft)		
Chloroethane	75-00-3	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
1,1-Dichloroethane	75-34-3	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
1,1-Dichloroethene	75-35-4	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
Trans-1,2-Dichloroethene	156-60-5	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
Methylene chloride	75-09-2	April-94	81	42	46	49	44	320	330	320	220	100	220	240	69	42	330
1,1,1-Trichloroethane	71-55-6	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
Trichloroethene	79-01-6	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
Vinyl chloride	75-01-4	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0

TABLE 2.1e

1994 ANALYTICAL DATA SUMMARY FOR ORGANIC CONSTITUENTS DETECTED IN SOIL BORINGS

HENKEL SURFACE TECHNOLOGIES

Parameter	CAS #	Date Sampled	SB-24 (2-4 ft)	SB-24 (8-10 ft)	SB-25 (0-2ft)	SB-25 (2-4 ft)	SB-25 (8-10 ft)	SB-26 (0-2ft)	SB-26 (2-4 ft)	SB-26 (8-10 ft)	SB-27 (0-2ft)	SB-27 (2-4 ft)	SB-27 (8-10 ft)	SB-28 (0-2ft)	SB-28 (2-4 ft)	SB-30 (8-10 ft)	Min. Detected	Max. Detected
Chloroethane	75-00-3	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
1,1-Dichloroethane	75-34-3	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
1,1-Dichloroethene	75-35-4	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
Trans-1,2-Dichloroethene	156-60-5	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
Methylene chloride	75-09-2	April-94	130	86	83	180	<10	77	190	130	40	130	<10	52	160	<10	40	190
1,1,1-Trichloroethane	71-55-6	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
Trichloroethene	79-01-6	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
Vinyl chloride	75-01-4	April-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0

Parameter	CAS #	Date Sampled	SB-7 (0-2 ft)	SB-7 (2-4 ft)	SB-12 (02- ft)	SB-12 (2-4 ft)	SB-21 (0-2 ft)	SB-21 (2-4 ft)	SB-23 (6-8 ft)	SB-29 (0-2 ft)	SB-30 (0-2 ft)	SB-30 (2-4 ft)	Min. Detected	Max. Detected
Chloroethane	75-00-3	July-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
1,1-Dichloroethane	75-34-3	July-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
1,1-Dichloroethene	75-35-4	July-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
Trans-1,2-Dichloroethene	156-60-5	July-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
Methylene chloride	75-09-2	July-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
1,1,1-Trichloroethane	71-55-6	July-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
Trichloroethene	79-01-6	July-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0
Vinyl chloride	75-01-4	July-94	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	0	0

Notes:

All results in units of ug/kg

MDL for all constituents is 10 ug/kg

Source: Interim Soil Report - Closure Activities, Parker Amchem, Hazardous Waste Storage Pads, Dragun Corporation, January 31, 1995

TABLE 2.1f

APRIL 1994 ANALYTICAL DATA SUMMARY FOR INORGANIC CONSTITUENTS DETECTED IN BACKGROUND SOILS

HENKEL SURFACE TECHNOLOGIES

Parameter	CAS #	BB-1 (0-2 ft)	BB-1 (4-6 ft)	BB-1 (6-8 ft)	BB-1 (8-10 ft)	BB-2 (0-2 ft)	BB-2 (2-4 ft)	BB-2 (4-6 ft)	BB-2 (6-8 ft)	BB-2 (8-10 ft)
Copper	7440-50-8	5.1	7.2	6	17	10	14	6.8	8.8	13
Chromium	18540-29-9	10	4.6	4.6	25	9.5	4.8	4.6	3.5	9.2
Lead	7439-92-1	12	3.5	3.8	10	20	6.5	4.6	3.6	6.5
Zinc	7440-66-6	34	18	19	46	50	57	24	30	39

Parameter	CAS #	BB-3 (0-2 ft)	BB-3 (2-4 ft)	BB-3 (4-6 ft)	BB-3 (6-8 ft)	BB-3 (8-10 ft)	BB-4 (0-2 ft)	BB-4 (2-4 ft)	BB-4 (4-6 ft)	BB-4 (6-8 ft)
Copper	7440-50-8	7.7	8.3	8.3	16	10	13	18	15	18
Chromium	18540-29-9	9.6	4.4	5.5	18	8.2	14	21	20	20
Lead	7439-92-1	6.6	3.5	3.6	7.4	4.3	9.3	11	8.2	8.8
Zinc	7440-66-6	21	24	27	47	34	38	46	58	50

Parameter	CAS #	BB-4 (8-10 ft)	BB-5 (0-2 ft)	BB-5 (2-4 ft)	BB-5 (4-6 ft)	BB-5 (6-8 ft)	BB-5 (8-10 ft)
Copper	7440-50-8	8	14	9.4	16	18	10
Chromium	18540-29-9	3.9	13	6.5	17	20	7.8
Lead	7439-92-1	3.4	16	5	8.2	9.6	4.4
Zinc	7440-66-6	20	41	21	39	46	30

		0-2 ft	2-4 ft	4-6 ft	6-8ft	8-10ft	2-10 FT
Average Concentrations	Copper	10.0	12.4	10.7	13.4	11.6	12.0
	Chromium	11.2	9.2	10.3	13.2	10.8	10.9
	Lead	12.8	6.5	5.6	6.6	5.7	6.1
	Zinc	36.8	37.0	33.2	38.4	33.8	35.6

Notes:

All concentrations in units of mg/kg

Source: Interim Soil Report - Closure Activities, Parker Amchem, Hazardous Waste Storage Pads, Dragun Corporation, January 31, 1995

TABLE 2.1g

APRIL 1994 ANALYTICAL DATA SUMMARY FOR INORGANIC CONSTITUENTS DETECTED IN SOIL BORINGS

HENKEL SURFACE TECHNOLOGIES

Sample Depth: 0-2 ft

Parameter	CAS #	SB-1	SB-2	SB-3	SB-4	SB-5	SB-6	SB-7	SB-8	SB-9
Copper	7440-50-8	12	15	12	15	12	13	20	8.9	19
Chromium	18540-29-9	29	11	10	12	18	12	15	143	77
Lead	7439-92-1	39	23	55	116	22	125	24	21	55
Zinc	7440-66-6	540	140	153	320	230	340	200	95	670

Parameter	CAS #	SB-10	SB-11	SB-12	SB-13	SB-14	SB-15	SB-16	SB-17	SB-18
Copper	7440-50-8	22	4.3	7.6	7.7	14	15	29	10	30
Chromium	18540-29-9	52	4.8	9.2	7.7	11	9	12	8.1	20
Lead	7439-92-1	53	2.8	14	14	38	16	90	14	140
Zinc	7440-66-6	540	19	95	50	130	41	264	30	130

Parameter	CAS #	SB-19	SB-20	SB-21	SB-22	SB-23	SB-24	SB-25	SB-26	SB-27
Copper	7440-50-8	13	35	85	14	58	43	108	570	6.2
Chromium	18540-29-9	30	31	160	19	102	106	115	52	7.1
Lead	7439-92-1	18	74	100	9.6	203	270	130	240	4.8
Zinc	7440-66-6	270	224	900	51	1700	1400	1160	590	56

Parameter	CAS #	SB-28	SB-29	SB-30	SB-31
Copper	7440-50-8	6	41	26	6.3
Chromium	18540-29-9	7.2	16	17	21
Lead	7439-92-1	6.3	72	120	5.5
Zinc	7440-66-6	1060	1060	740	27

TABLE 2.1g

APRIL 1994 ANALYTICAL DATA SUMMARY FOR INORGANIC CONSTITUENTS DETECTED IN SOIL BORINGS

HENKEL SURFACE TECHNOLOGIES

Sample Depth: 2-4 ft

Parameter	CAS #	SB-13	SB-23	SB-24
Copper	7440-50-8	3.3	ND	ND
Chromium	18540-29-9	3.9	ND	ND
Lead	7439-92-1	3.2	ND	ND
Zinc	7440-66-6	16	33.3	403

Sample Depth: 6-8 ft

Parameter	CAS #	SB-23	SB-24
Copper	7440-50-8	ND	ND
Chromium	18540-29-9	ND	ND
Lead	7439-92-1	ND	ND
Zinc	7440-66-6	12.5	155

Sample Depth: 4-6 ft

Parameter	CAS #	SB-5	SB-23	SB-24
Copper	7440-50-8	6.9	ND	ND
Chromium	18540-29-9	6.2	ND	ND
Lead	7439-92-1	5.5	ND	ND
Zinc	7440-66-6	30	93.7	1113

Sample Depth: 8-10 ft

Parameter	CAS #	SB-23	SB-24
Copper	7440-50-8	ND	ND
Chromium	18540-29-9	ND	ND
Lead	7439-92-1	ND	ND
Zinc	7440-66-6	12.2	100

Notes:

All concentrations in units of mg/kg

Source: Interim Soil Report - Closure Activities, Parker Amchem, Hazardous Waste Storage Pads, Dragun Corporation, January 31, 1995

TABLE 2.2a
ANALYTICAL DATA SUMMARY FOR CONSTITUENTS DETECTED IN GROUNDWATER
SEPTEMBER 17 AND 18, 2002
HENKEL SURFACE TECHNOLOGIES

Parameter	CAS #	Units	MDL	MW-1 (HST)	MW-2 (HST)	MW-3 (HST)	MW-4 (HST)	MW-200 (HST)	Trip Blank (HST)	MW-3 (CRL)	MW-3 DUP (CRL)	Field Blank (CRL)	Min. Detected	Max. Detected
1,1,1,2-Tetrachloroethane	630-20-6	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
1,1,1-Trichloroethane	71-55-6	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
1,1,2,2-Tetrachloroethane	79-34-5	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
1,1,2-Trichloroethane	79-00-5	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
1,2-Dibromomethane	106-93-4	ug/L	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0
1,1-Dichloroethane	75-34-3	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
1,1-Dichloroethene	75-35-4	ug/L	1	<1	<1	3.3	<1	3.4	<1	3J	3J	5U	3.3	3.4
1,1-Dichloropropene	563-58-6	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
1,2,3-Trichlorobenzene	87-61-6	ug/L	5	<5	<5	<5	<5	<5	<5	5U	5U	5U	0	0
1,2,3-Trichloropropane	96-18-4	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
1,2,4-Trichlorobenzene	120-82-1	ug/L	5	<5	<5	<5	<5	<5	<5	5U	5U	5U	0	0
1,2,4-Trimethylbenzene	95-63-6	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
1,2-Dibromo-3-chloropropane	96-12-8	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
1,2-Dichlorobenzene	95-50-1	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
1,2-Dichloroethane	107-06-2	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
1,2-Dichloropropane	78-87-5	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
1,3,5-Trimethylbenzene	108-67-8	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
1,3-Dichlorobenzene	541-73-1	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
1,3-Dichloropropane	142-28-9	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
1,4-Dichlorobenzene	106-46-7	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
2,2-Dichloropropane	594-20-7	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
2-Butanone (MEK)	78-93-3	ug/L	N/A	N/A	N/A	N/A	N/A	N/A	N/A	25U	25U	25U	0	0
2-Chloroethyl vinyl ether	110-75-8	ug/L	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10U	10U	10U	0	0
2-Hexanone	591-78-6	ug/L	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10U	10U	10U	0	0
2-Chlorotoluene	95-49-8	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
4-Chlorotoluene	95-49-8	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
2-Methylnaphthalene	91-57-6	ug/L	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0
4-Methyl-2-pentanone	108-10-1	ug/L	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10U	10U	10U	0	0
Acetone	67-64-1	ug/L	N/A	N/A	N/A	N/A	N/A	N/A	N/A	25U	25U	9J	0	0
Acrolein	107-02-8	ug/L	N/A	N/A	N/A	N/A	N/A	N/A	N/A	25U	25U	25U	0	0
Acrylonitrile	107-13-1	ug/L	N/A	N/A	N/A	N/A	N/A	N/A	N/A	25U	25U	25U	0	0
Benzene	71-43-2	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
Bromobenzene	108-86-1	ug/L	1	<1	<1	<1	<1	<1	<1	10U	10U	10U	0	0
Bromochloromethane	74-97-5	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
Bromodichloromethane	75-27-4	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
Bromoform	75-25-2	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
Bromomethane	74-83-9	ug/L	1	<1	<1	<1	<1	<1	<1	10U	10U	10U	0	0
Carbon disulfide	75-15-0	ug/L	5	N/A	N/A	N/A	N/A	N/A	N/A	5U	5U	5U	0	0
Carbon tetrachloride	56-23-5	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
Chlorobenzene	108-90-7	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0

TABLE 2.2a
ANALYTICAL DATA SUMMARY FOR CONSTITUENTS DETECTED IN GROUNDWATER
SEPTEMBER 17 AND 18, 2002
HENKEL SURFACE TECHNOLOGIES

Parameter	CAS #	Units	MDL	MW-1 (HST)	MW-2 (HST)	MW-3 (HST)	MW-4 (HST)	MW-200 (HST)	Trip Blank (HST)	MW-3 (CRL)	MW-3 DUP (CRL)	Field Blank (CRL)	Min. Detected	Max. Detected
Chloroethane	75-00-3	ug/L	1	<1	<1	<1	<1	<1	<1	10U	10U	10U	0	0
Chloroform	67-66-3	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
Chloromethane	74-87-3	ug/L	1	<1	<1	<1	<1	<1	<1	10U	10U	10U	0	0
Cis-1,2-dichloroethene	156-59-2	ug/L	1	<1	<1	50	<1	51	<1	36	33	5U	33	51
Cis-1,3-dichloropropene	54-27-56	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
Dibromochloromethane	124-48-1	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
Dibromomethane	74-95-3	ug/L	5	<5	<5	<5	<5	<5	<5	N/A	N/A	N/A	0	0
Dichlorodifluoromethane	75-71-8	ug/L	1	<1	<1	<1	<1	<1	<1	N/A	N/A	N/A	0	0
Diethyl ether	60-29-7	ug/L	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0
Ethylbenzene	100-41-4	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
Ethylene dibromide	106-93-4	ug/L	1	<1	<1	<1	<1	<1	<1	N/A	N/A	N/A	0	0
Hexachlorobutadiene	87-68-3	ug/L	5	<5	<5	<5	<5	<5	<5	5U	5U	5U	0	0
Hexachloroethane	67-72-1	ug/L	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0
Isopropylbenzene	98-82-8	ug/L	5	<5	<5	<5	<5	<5	<5	5U	5U	5U	0	0
M-and/or p-xylene	133-02-07	ug/L	2	<2	<2	<2	<2	<2	<2	10U	10U	10U	0	0
Methylene chloride	75-09-2	ug/L	5	<5	<5	<5	<5	<5	<5	5U	5U	5U	0	0
Methyl iodide	74-88-4	ug/L	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0
Methyltertbutylether (MTBE)	1634-04-4	ug/L	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0
N-Butylbenzene	10-45-18	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
N-Propylbenzene	103-65-1	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
Naphthalene	91-20-3	ug/L	5	<5	<5	<5	<5	<5	<5	5U	5U	5U	0	0
O-Xylene	133-02-07	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
P-Isopropyltoluene	99-87-6B	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
Sec-Butylbenzene	135-9-88	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
Styrene	100-42-5	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
Tert-Butylbenzene	98-06-6	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
Tetrachloroethene	127-18-4	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
Toluene	108-88-3	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
Trans-1,2-Dichloroethene	156-60-5	ug/L	1	<1	<1	<1	<1	<1	<1	13	14	5U	13	14
Trans-1,3-Dichloropropene	54-27-56	ug/L	1	<1	<1	<1	<1	<1	<1	5U	5U	5U	0	0
Trans-1,4-Dichloro-2-butene	110-57-6	ug/L	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0
Trichloroethene	79-01-6	ug/L	1	<1	<1	2.8	<1	3.3	<1	4J	4J	5U	2.8	3.3
Trichlorofluoromethane	75-69-4	ug/L	1	<1	<1	<1	<1	<1	<1	N/A	N/A	N/A	0	0
Vinyl chloride	75-01-4	ug/L	1	<1	<1	19	<1	20	<1	31	29	10U	19	31
Xylenes	133-02-07	ug/L	3	<3	<3	<3	<3	NA	<3	N/A	N/A	N/A	0	0

Notes:
Source for data: Summary Report Soil and Grounwater Sampling, Henkel Surface Technologies Faiclity, Morenci, Michigan, MID 058-723-867, Dragun Corporation, October 30, 2002.
N/A: not anlayzed or not available (MDL)
HST: Henkel Surface technologies
CRL: Central Regioanl Laboratory, split sample results

TABLE 2.2b

ANALYTICAL DATA SUMMARY FOR CONSTITUENTS DETECTED IN GROUNDWATER

AUGUST AND NOVEMBER 1998 DATA

HENKEL SURFACE TECHNOLOGIES

Parameter	CAS #	Units	MDL	MW-1 (08/98)	MW-2 (8/98)	MW-3 (8/98)	MW-4 (8/98)	MW-X (8/98)
Hexavalent Chromium	18540-29-9	ug/L	5	<5	<5	<5	<5	<5
Copper	7440-50-8	ug/L	25	<25	<25	<25	<25	<25
Lead	7439-92-1	ug/L	3	<3	<3	<3	<3	<3
Zinc	7440-66-6	ug/L	20	<20	<20	<20	<20	<20

Parameter	CAS #	Units	MDL	MW-1 (11/98)	MW-2(11/98)	MW-3 (11/98)	MW-4 (11/98)	MW-X (11/98)
Hexavalent Chromium	18540-29-9	ug/L	5	<5	<5	<5	<5	<5
Copper	7440-50-8	ug/L	25	<25	<25	<25	<25	<25
Lead	7439-92-1	ug/L	3	<3	<3	<3	<3	<3
Zinc	7440-66-6	ug/L	20	<20	<20	<20	<20	<20

Notes:

Source for data: Groundwater Sampling Henkel Surface technologies Facility, Morenci, Michigan, MID-058-723-867, January 28, 1999

MW-X - Duplicate Samples from MW-4

All results represent dissolved metals

TABLE 2.2c

ANALYTICAL DATA SUMMARY FOR CONSTITUENTS DETECTED IN GROUNDWATER

AUGUST 4, 1998

HENKEL SURFACE TECHNOLOGIES

Parameter	CAS #	Units	MDL	MW-1	MW-2	MW-3	MW-4	Field Blank (FB)
1,1,1,2-Tetrachloroethane	630-20-6	ug/L	1	<1	<1	<1	<1	<1
1,1,1-Trichloroethane	71-55-6	ug/L	1	<1	<1	<1	<1	<1
1,1,2,2-Tetrachloroethane	79-34-5	ug/L	1	<1	<1	<1	<1	<1
1,1,2-Trichloroethane	79-00-5	ug/L	1	<1	<1	<1	<1	<1
1,2-Dibromomethane	106-93-4	ug/L	1	<1	<1	<1	<1	<1
1,1-Dichloroethane	75-34-3	ug/L	1	<1	<1	<1	<1	<1
1,1-Dichloroethene	75-35-4	ug/L	1	<1	<1	1.7	<1	<1
1,1-Dichloropropene	563-58-6	ug/L	N/A	N/A	N/A	N/A	N/A	N/A
1,2,3-Trichlorobenzene	87-61-6	ug/L	N/A	N/A	N/A	N/A	N/A	N/A
1,2,3-Trichloropropane	96-18-4	ug/L	1	<1	<1	<1	<1	<1
1,2,4-Trichlorobenzene	120-82-1	ug/L	5	<5	<5	<5	<5	<5
1,2,4-Trimethylbenzene	95-63-6	ug/L	1	<1	<1	<1	<1	<1
1,2-Dibromo-3-chloropropane	96-12-8	ug/L	5	<5	<5	<5	<5	<5
1,2-Dichlorobenzene	95-50-1	ug/L	1	<1	<1	<1	<1	<1
1,2-Dichloroethane	107-06-2	ug/L	1	<1	<1	<1	<1	<1
1,2-Dichloropropane	78-87-5	ug/L	1	<1	<1	<1	<1	<1
1,3,5-Trimethylbenzene	108-67-8	ug/L	1	<1	<1	<1	<1	<1
1,3-Dichlorobenzene	541-73-1	ug/L	1	<1	<1	<1	<1	<1
1,3-Dichloropropane	142-28-9	ug/L	N/A	N/A	N/A	N/A	N/A	N/A
1,4-Dichlorobenzene	106-46-7	ug/L	1	<1	<1	<1	<1	<1
2,2-Dichloropropane	594-20-7	ug/L	1	N/A	N/A	N/A	N/A	N/A
2-Butanone (MEK)	78-93-3	ug/L	5	<5	<5	<5	<5	<5
2-Chloroethyl vinyl ether	110-75-8	ug/L	N/A	N/A	N/A	N/A	N/A	N/A
2-Hexanone	591-78-6	ug/L	5	<5	<5	<5	<5	<5
2-Chlorotoluene	95-49-8	ug/L	N/A	N/A	N/A	N/A	N/A	N/A
4-Chlorotoluene	95-49-8	ug/L	N/A	N/A	N/A	N/A	N/A	N/A
2-Methylnaphthalene	91-57-6	ug/L	5	<5	<5	<5	<5	<5

TABLE 2.2c

ANALYTICAL DATA SUMMARY FOR CONSTITUENTS DETECTED IN GROUNDWATER

AUGUST 4, 1998

HENKEL SURFACE TECHNOLOGIES

Parameter	CAS #	Units	MDL	MW-1	MW-2	MW-3	MW-4	Field Blank (FB)
4-Methyl-2-pentanone	108-10-1	ug/L	5	<5	<5	<5	<5	<5
Acetone	67-64-1	ug/L	25	<25	<25	<25	<25	<25
Acrolein	107-02-8	ug/L	N/A	N/A	N/A	N/A	N/A	N/A
Acrylonitrile	107-13-1	ug/L	5	<5	<5	<5	<5	<5
Benzene	71-43-2	ug/L	1	<1	<1	<1	<1	<1
Bromobenzene	108-86-1	ug/L	N/A	N/A	N/A	N/A	N/A	N/A
Bromochloromethane	74-97-5	ug/L	1	<1	<1	<1	<1	<1
Bromodichloromethane	75-27-4	ug/L	1	<1	<1	<1	<1	<1
Bromoform	75-25-2	ug/L	1	<1	<1	<1	<1	<1
Bromomethane	74-83-9	ug/L	5	<5	<5	<5	<5	<5
Carbon disulfide	75-15-0	ug/L	5	<5	<5	<5	<5	<5
Carbon tetrachloride	56-23-5	ug/L	1	<1	<1	<1	<1	<1
Chlorobenzene	108-90-7	ug/L	1	<1	<1	<1	<1	<1
Chloroethane	75-00-3	ug/L	5	<5	<5	<5	<5	<5
Chloroform	67-66-3	ug/L	1	<1	<1	<1	<1	<1
Chloromethane	74-87-3	ug/L	5	<5	<5	<5	<5	<5
Cis-1,2-dichloroethene	156-59-2	ug/L	1	<1	<1	**46**	<1	<1
Cis-1,3-dichloropropene	54-27-56	ug/L	1	<1	<1	<1	<1	<1
Dibromochloromethane	124-48-1	ug/L	1	<1	<1	<1	<1	<1
Dibromomethane	74-95-3	ug/L	1	<1	<1	<1	<1	<1
Dichlorodifluoromethane	75-71-8	ug/L	5	<5	<5	<5	<5	<5
Diethyl ether	60-29-7	ug/L	10	<10	<10	<10	<10	<10
Ethylbenzene	100-41-4	ug/L	1	<1	<1	<1	<1	<1

TABLE 2.2c

ANALYTICAL DATA SUMMARY FOR CONSTITUENTS DETECTED IN GROUNDWATER

AUGUST 4, 1998

HENKEL SURFACE TECHNOLOGIES

Parameter	CAS #	Units	MDL	MW-1	MW-2	MW-3	MW-4	Field Blank (FB)
4-Methyl-2-pentanone	108-10-1	ug/L	5	<5	<5	<5	<5	<5
Acetone	67-64-1	ug/L	25	<25	<25	<25	<25	<25
Acrolein	107-02-8	ug/L	N/A	N/A	N/A	N/A	N/A	N/A
Acrylonitrile	107-13-1	ug/L	5	<5	<5	<5	<5	<5
Benzene	71-43-2	ug/L	1	<1	<1	<1	<1	<1
Bromobenzene	108-86-1	ug/L	N/A	N/A	N/A	N/A	N/A	N/A
Bromochloromethane	74-97-5	ug/L	1	<1	<1	<1	<1	<1
Bromodichloromethane	75-27-4	ug/L	1	<1	<1	<1	<1	<1
Bromoform	75-25-2	ug/L	1	<1	<1	<1	<1	<1
Bromomethane	74-83-9	ug/L	5	<5	<5	<5	<5	<5
Carbon disulfide	75-15-0	ug/L	5	<5	<5	<5	<5	<5
Carbon tetrachloride	56-23-5	ug/L	1	<1	<1	<1	<1	<1
Chlorobenzene	108-90-7	ug/L	1	<1	<1	<1	<1	<1
Chloroethane	75-00-3	ug/L	5	<5	<5	<5	<5	<5
Chloroform	67-66-3	ug/L	1	<1	<1	<1	<1	<1
Chloromethane	74-87-3	ug/L	5	<5	<5	<5	<5	<5
Cis-1,2-dichloroethene	156-59-2	ug/L	1	<1	<1	**46**	<1	<1
Cis-1,3-dichloropropene	54-27-56	ug/L	1	<1	<1	<1	<1	<1
Dibromochloromethane	124-48-1	ug/L	1	<1	<1	<1	<1	<1
Dibromomethane	74-95-3	ug/L	1	<1	<1	<1	<1	<1
Dichlorodifluoromethane	75-71-8	ug/L	5	<5	<5	<5	<5	<5
Diethyl ether	60-29-7	ug/L	10	<10	<10	<10	<10	<10
Ethylbenzene	100-41-4	ug/L	1	<1	<1	<1	<1	<1

TABLE 2.2c

ANALYTICAL DATA SUMMARY FOR CONSTITUENTS DETECTED IN GROUNDWATER

AUGUST 4, 1998

HENKEL SURFACE TECHNOLOGIES

Parameter	CAS #	Units	MDL	MW-1	MW-2	MW-3	MW-4	Field Blank (FB)
Ethylene dibromide	106-93-4	ug/L	N/A	N/A	N/A	N/A	N/A	N/A
Hexachlorobutadiene	87-68-3	ug/L	N/A	N/A	N/A	N/A	N/A	N/A
Hexachloroethane	67-72-1	ug/L	1	<1	<1	<1	<1	<1
Isopropylbenzene	98-82-8	ug/L	1	<1	<1	<1	<1	<1
M-and/or p-xylene	133-02-07	ug/L	2	<2	<2	<2	<2	<2
Methylene chloride	75-09-2	ug/L	5	<5	<5	<5	<5	<5
Methyl iodide	74-88-4	ug/L	1	<1	<1	<1	<1	<1
Methyltertbutylether (MTBE)	1634-04-4	ug/L	5	<5	<5	<5	<5	<5
N-Butylbenzene	10-45-18	ug/L	N/A	N/A	N/A	N/A	N/A	N/A
N-Propylbenzene	103-65-1	ug/L	1	<1	<1	<1	<1	<1
Naphthalene	91-20-3	ug/L	5	<5	<5	<5	<5	<5
O-Xylene	133-02-07	ug/L	1	<1	<1	<1	<1	<1
P-Isopropyltoluene	99-87-6B	ug/L	N/A	N/A	N/A	N/A	N/A	N/A
Sec-Butylbenzene	135-9-88	ug/L	N/A	N/A	N/A	N/A	N/A	N/A
Styrene	100-42-5	ug/L	1	<1	<1	<1	<1	<1
Tert-Butylbenzene	98-06-6	ug/L	N/A	N/A	N/A	N/A	N/A	N/A
Tetrachloroethene	127-18-4	ug/L	1	<1	<1	<1	<1	<1
Toluene	108-88-3	ug/L	1	<1	<1	<1	<1	<1
Trans-1,2-Dichloroethene	156-60-5	ug/L	1	<1	<1	<1	<1	<1
Trans-1,3-Dichloropropene	54-27-56	ug/L	1	<1	<1	<1	<1	<1
Trans-1,4-Dichloro-2-butene	110-57-6	ug/L	1	<1	<1	<1	<1	<1
Trichloroethene	79-01-6	ug/L	1	<1	<1	**17**	<1	<1
Trichlorofluoromethane	75-69-4	ug/L	5	<5	<5	**5.4**	<5	<5
Vinyl chloride	75-01-4	ug/L	5	<5	<5	<5	<5	<5
Xylenes	133-02-07	ug/L	N/A	N/A	N/A	N/A	N/A	N/A

TABLE 2.2c

ANALYTICAL DATA SUMMARY FOR CONSTITUENTS DETECTED IN GROUNDWATER

AUGUST 4, 1998

HENKEL SURFACE TECHNOLOGIES

Parameter	CAS #	Units	MDL	MW-1	MW-2	MW-3	MW-4	Field Blank (FB)
Arsenic[1]	7440-38-2	ug/L	1	<1	1.6	1.4	6	<1
Cadmium[1]	7440-43-9	ug/L	0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Hexavalent Chromium[2]	18540-29-9	ug/L	5	<5	<5	<5	<5	<5
Total Chromium[1]		ug/L	1	<1	<1	<1	<1	<1
Calcium[2]	7440-70-2	mg/L	1	97	67	182	45	<1
Copper[1]	7440-50-8	ug/L	1	<1	<1	<1	<1	<1
Iron[2]	7439-89-6	ug/L	20	<20	<20	<20	<20	<20
Potassium[2]	9/7/40	mg/L	1	75	54	93	66	<1
Magnesium[2]	7439-95-4	mg/L	1	21	19	86	18	<1
Sodium[2]	1734-12-52	mg/L	1	41	46	997	68	<1
Nickel[1]	7440-02-0	ug/L	2	3.1	3.4	33	67.2	<2
Lead[1]	7439-92-1	ug/L	1	<1	<1	<1	<1	<1
Zinc[2]	7440-66-6	ug/L	4	7	17	<4	<4	<4

Notes:

Source for data: Interoffice Communication of Split Sample Results, from Clay Spencer to Monitoring File Data, MDEQ Environemntal Laboratory, September 17, 1998.

N/A: not anlayzed

[1] Total dissolved metal concentration

[2] Maximum of total in water

TABLE 2.2d

ANALYTICAL DATA SUMMARY FOR CONSTITUENTS DETECTED IN GROUNDWATER

Second, Third and Forth Quart 1994 and First Quarter 1995

HENKEL SURFACE TECHNOLOGIES

Parameter	CAS #	Units	MDL	MW-1 (4/94)	MW-1 (7/94)	MW-1 (10/94)	MW-1 (1/95)	MW-2 (4/94)	MW-2 (7/94)	MW-2 (10/94)	MW-2 (1/95)	MW-3 (4/94)	MW-3 (7/94)	MW-3 (10/94)	MW-3X (10/94)	MW-3 (1/95)	MW-3X (1/95)	MW-4 (4/94)	MW-4 (7/94)	MW-4X (7/94)	MW-4 (10/94)	MW-4 (1/95)	Min. Detected	Max. Detected
Bromobenzene	108-86-1	ug/L	1	N/A	N/A	N/A	<1	N/A	N/A	N/A	<1	N/A	N/A	N/A	N/A	<1	<1	N/A	N/A	N/A	N/A	<1	0	0
Bromochloromethane	74-97-5	ug/L	N/A	N/A	N/A	N/A	<1	N/A	N/A	N/A	<1	N/A	N/A	N/A	N/A	<1	<1	N/A	N/A	N/A	N/A	<1	0	0
1-Chloro-2-Bromopropane		ug/L	N/A	N/A	N/A	N/A	<1	N/A	N/A	N/A	<1	N/A	N/A	N/A	N/A	<1	<1	N/A	N/A	N/A	N/A	<1	0	0
Bromodichloromethane	75-27-4	ug/L	1	<1	<1	1	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	2
Bromoform	75-25-2	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0	0
Bromomethane	74-83-9	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0	0
Carbon tetrachloride	56-23-5	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0	0
Chlorobenzene	108-90-7	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0	0
Chloroethane	75-00-3	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0	0
2-Chloroethyl vinyl ether	110-75-8	ug/L	10	<10	<1	<1	<1	<10	<1	<1	<1	<10	<1	<1	<1	<1	<1	<10	<1	<1	<1	<1	0	0
Chloroform	67-66-3	ug/L	1	<1	2	2	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	2
Chloromethane	74-87-3	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0	0
Dibromochloromethane	124 48-1	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0	0
Dibromomethane	74-95-3	ug/L	N/A	N/A	N/A	N/A	<1	N/A	N/A	N/A	<1	N/A	N/A	N/A	N/A	<1	N/A	N/A	N/A	N/A	N/A	<1	0	0
1,2-Dichlorobenzene	95-50-1	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0	0
1,3-Dichlorobenzene	541-73-1	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0	0
1,4-Dichlorobenzene	106-46-7	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0	0
Dichlorodifluoromethane	75-71-8	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0	0
1,1-Dichloroethane	75-34-3	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	3	3	<1	<1	<1	<1	2	2	3
1,2-Dichloroethane	107-06-2	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0	0
1,1-Dichloroethene	75-35-4	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	3	<1	7	6	<1	<1	3	<1	<1	<1	<1	3	7
Trans-1,2-Dichloroethene	156-60-5	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0	0
1,2-Dichloropropane	78-87-5	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0	0
Cis-1,3-dichloropropane	54-27-56	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0	0
Trans-1,3-Dichloropropene	54-27-56	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0	0
Methylene chloride	75-09-2	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0	0
1,1,1,2-Tetrachloroethane	630-20 6	ug/L	1	N/A	N/A	<1	<1	N/A	N/A	N/A	<1	N/A	N/A	N/A	N/A	<1	<1	N/A	N/A	N/A	N/A	<1	0	0
1,1,2,2-Tetrachloroethane	79-34-5	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0	0
Tetrachloroethene	127-18-4	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0	0
1,1,1-Trichloroethane	71-55 6	ug/L	1	<1	<1	<1	<1	<1	<1	<1	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2	2
1,1,2-Trichloroethane	79-00-5	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0	0
Trichloroethene	79-01-6	ug/L	1	3	<1	<1	<1	<1	<1	<1	<1	24	5	43	42	29	29	3	<1	<1	<1	<1	3	43
Trichlorofluoromethane	75-69-4	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0	0
1,2,3-Trichloropropane	96-18-4	ug/L	1	N/A	N/A	N/A	<1	N/A	N/A	N/A	<1	N/A	N/A	N/A	N/A	<1	<1	N/A	N/A	N/A	N/A	<1	0	0
Vinyl chloride	75-01-4	ug/L	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	4	22	24	16	17	<1	<1	<1	<1	<1	4	24

TABLE 2.2d

ANALYTICAL DATA SUMMARY FOR CONSTITUENTS DETECTED IN GROUNDWATER

Second, Third and Forth Quart 1994 and First Quarter 1995

HENKEL SURFACE TECHNOLOGIES

Parameter	CAS #	Units	MDL	MW-1 (4/94)	MW-1 (7/94)	MW-1X (9/94)	MW-1 (10/94)	MW-1 (1/95)	MW-2 (4/94)	MW-2 (7/94)	MW-2 (10/94)	MW-2 (1/95)
Chromium, total		ug/L	1	<50	5.6	N/A	5	1.9	<50	4	1	1.4
Copper	7440-50 8	ug/L	25	<25	32	N/A	15	<25	<25	<20	11	<25
Lead	7439-92-1	ug/L	3	<3	110	<3	4.7	<3	<3	<3	3.3	3.6
Zinc	7440-66-6	ug/L	20	<20	100	N/A	36	22	57	39	130	37

Parameter	MW-3 (4/94)	MW-3 (7/94)	MW-3 (10/94)	MW-3X (10/94	MW-3 (1/95)	MW-3X (1/95)	MW-4 (4/94)	MW-4 (7/94)	MW-4X (7/94)	MW-4 (10/94)	MW-4 (1/95)	Min. Detected
Chromium, total	<50	3.4	3.4	<11	1.7	1.5	<50	2	1.6	<1	<1	1
Copper	<25	<20	5	3.7	25	<25	<25	<20	<200	6.5	56	3.7
Lead	<3	<3	1.9	1.4	<3	<3	<3	<3	<3	3.4	6.5	1.4
Zinc	<20	32	44	37	100	26	<20	77	49	50	25	22

Notes.

Source for data, Interoffice Communication of Split Sample Results, from Clay Spencer to Monitoring File Data, MDEQ Environemntal Laboratory, September 17, 1998.

MW-X: duplicate sample

N/A: not anlayzed

All inorganic results are dissolved metals

TABLE 2.3

SCREENING CRITERIA FOR CONSTITUENTS DETECTED IN SOIL

HENKEL SURFACE TECHNOLOGIES

Parameter	Maximum Detected Concentration	Units	Screening Criteria Value	Units	Screening Criteria Source
1,2,4-Trimethylbenzene	100	ug/kg	110,000	ug/kg	Direct Contact, Industrial and Commercial II and Indoor Ai
Acenaphthene	450	ug/kg	4,400	ug/kg	Groundwater Surface Water Interface Protection
Acenphthylene	570	ug/kg	440,000	ug/kg	Groundwater Protection Criterion
Anthracene	2,000	ug/kg	41,000	ug/kg	Groundwater Protection Criterion
Benzo(a)anthracene	6,800	ug/kg	100,000	ug/kg	Direct Contact, Industrial and Commercial II
Benzo(a)pyrene	6,100	ug/kg	10,000	ug/kg	Direct Contact, Industrial and Commercial II
Benzo(b)fluoranthene	9,600	ug/kg	100,000	ug/kg	Direct Contact, Industrial and Commercial II
Benzo(g,h,i)perylene	730	ug/kg	9,100,000	ug/kg	Direct Contact, Industrial and Commercial II
Benzo(k)fluoranthene	1,200	ug/kg	1,000,000	ug/kg	Direct Contact, Industrial and Commercial II
Chromium (VI)	390,000	ug/kg	3,300	ug/kg	Groundwater Surface Water Interface Protection
Chrysene	4,900	ug/kg	10,000,000	ug/kg	Direct Contact, Industrial and Commercial II
Copper	570,000	ug/kg	59,000,000	ug/kg	Particulate Soil Inhalation Criterion
Dibenzo(a,h)anthracene	2,500	ug/kg	10,000	ug/kg	Direct Contact, Industrial and Commercial II
Fluoranthene	17,000	ug/kg	5,500	ug/kg	Groundwater Surface Water Interface Protection
Fluorene	1,200	ug/kg	5,300	ug/kg	Groundwater Surface Water Interface Protection
Indeno(1,2,3-c,d)pyrene	2,000	ug/kg	100,000	ug/kg	Direct Contact, Industrial and Commercial II
Lead	640,000	ug/kg	900000 (1)	ug/kg	Direct Contact, Industrial and Commercial II
M-and/or p-xylene	520	ug/kg	700	ug/kg	Groundwater Surface Water Interface Protection
Methylene chloride	320	ug/kg	19,000	ug/kg	Groundwater Surface Water Interface Protection
O-Xylene	190	ug/kg	700	ug/kg	Groundwater Surface Water Interface Protection
Phenanthrene	8,700	ug/kg	2,300	ug/kg	Groundwater Surface Water Interface Protection
Pyrene	15,000	ug/kg	480,000	ug/kg	Groundwater Contact Protection Criterion
Trichloroethene	100	ug/kg	4,000	ug/kg	Groundwater Surface Water Interface Protection
Xylenes	710	ug/kg	700	ug/kg	Groundwater Surface Water Interface Protection
Zinc	2,584,000	ug/kg	1,000,000,000	ug/kg	Direct Contact, Industrial and Commercial II

(1) Criterion for direct contact with lead for the Industrial and Commercial II worker is a draft number.

Groundwater is not an aquifer and use of groundwater is prohibited by an enforceable land use restriction, threrefore via Guidesheet #21, this drinking water pathway is not relevant.

Groundwater is connected to a surface water body, therefore Guideheet #12 applies.

TABLE 2.4

SCREENING CRITERIA FOR CONSTITUENTS DETECTED IN GROUNDWATER

HENKEL SURFACE TECHNOLOGIES

Parameter	Maximum Detected Concentration	Units	Screening Criteria Value	Units	Screening Criteria Source
1,1-Dichloroethane	3	ug/L	2,500	ug/L	Industrial & Commercial II, III, IV Drinking Water Criteria
1,1-Dichloroethene	7.0	ug/L	7	ug/L	Industrial & Commercial II, III, IV Drinking Water Criteria
Bromodichloromethane	2	ug/L	100	ug/L	Industrial & Commercial II, III, IV Drinking Water Criteria
Chloroform	2	ug/L	100	ug/L	Industrial & Commercial II, III, IV Drinking Water Criteria
Cis-1,2-Dichloroethene	51	ug/L	70	ug/L	Industrial & Commercial II, III, IV Drinking Water Criteria
Trans-1,2-Dichloroethene	13.5	ug/L	100	ug/L	Industrial & Commercial II, III, IV Drinking Water Criteria
Trichloroethene	43	ug/L	5	ug/L	Industrial & Commercial II, III, IV Drinking Water Criteria
Trichlorofluoromethane	5.4	ug/L	7,300	ug/L	Industrial & Commercial II, III, IV Drinking Water Criteria
1,1,1-Trichoroethane	2	ug/L	200	ug/L	Groundwater Surface Water Interface Criterion
Vinyl Chloride	30	ug/L	2	ug/L	Industrial & Commercial II, III, IV Drinking Water Criteria
Arsenic	6	ug/L	50	ug/L	Industrial & Commercial II, III, IV Drinking Water Criteria
Chromium, total (1)	5.6	ug/L	11	ug/L	Groundwater Surface Water Interface Criterion
Copper	32	ug/L	1,000	ug/L	Industrial & Commercial II, III, IV Drinking Water Criteria
Lead	110	ug/L	NA	ug/L	Groundwater Surface Water Interface Criterion, pH dependent
Nickel	67.2	ug/L	100	ug/L	Industrial & Commercial II, III, IV Drinking Water Criteria
Zinc	130	ug/L	5,000	ug/L	Industrial & Commercial II, III, IV Drinking Water Criteria

Groundwater restriction to industrial use only, therefore no drinking water criteria (Guidesheet No. 2) was deemed applicable.

(1) Chromium evaluated as Cr VI

TABLE 2.5

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

HENKEL SURFACE TECHNOLOGIES

Scenario Timeframe:	Current and Future
Medium:	Surface Soil
Exposure Medium:	Surface Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value	Screening Toxicity Value (2)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (3)
Soil	95-63-6	1,2,4-Trimethylbenzene	100	100	ug/kg	HA-13	1/16	100	100	NA	110,000	NA	NA	No	BSL
	83-32-9	Acenaphthene	450	450	ug/kg	HA-10	1/16	450	450	NA	4,400	NA	NA	No	BSL
	208-96-8	Acenphthylene	570	570	ug/kg	HA-10	1/16	570	570	NA	440,000	NA	NA	No	BSL
	120-12-7	Anthracene	2,000	2,000	ug/kg	HA-10	1/16	2,000	2,000	NA	41,000	NA	NA	No	BSL
	56-55-3	Benzo(a)anthracene	350	6,800	ug/kg	HA-10	5/16	350-6,800	2,537	NA	100,000	NA	NA	No	BSL
	50-32-8	Benzo(a)pyrene	670	6,100	ug/kg	HA-10	4/16	670-6,100	2,339	NA	10,000	NA	NA	No	BSL
	205-99-2	Benzo(b)fluoranthene	420	9,600	ug/kg	HA-10	7/16	420-9,600	3,552	NA	100,000	NA	NA	No	BSL
	191-24-2	Benzo(g,h,i)perylene	730	730	ug/kg	HA-10	1/16	730	730	NA	9,100,000	NA	NA	No	BSL
	207-08-9	Benzo(k)fluoranthene	50	1,200	ug/kg	HA-4	6/16	50-1,200	652	NA	1,000,000	NA	NA	No	BSL
	1854-02-99	Chromium (VI) (4)	1,450	390,000	ug/kg	SB-25	68/68	1,450-390,000	79,549	11,200	3,300	NA	NA	Yes	ASL
	218-01-9	Chrysene	400	4,900	ug/kg	HA-10	6/16	400-4,900	1,906	NA	10,000,000	NA	NA	No	BSL
	744-05-08	Copper	4,300	570,000	ug/kg	SB-26	46/47	4,300-570,000	100,243	10,000	59,000,000	NA	NA	No	BSL
	53-70-3	Dibenzo(a,h)anthracene	2,500	2,500	ug/kg	HA-10	1/16	2,500	2,500	NA	10,000	NA	NA	No	BSL
	206-44-0	Fluoranthene	340	17,000	ug/kg	HA-10	9/16	340-17,000	6,219	NA	5,500	NA	NA	Yes	ASL
	86-73-7	Fluorene	1,200	1,200	ug/kg	HA-10	1/16	1,200	1,200	NA	5,300	NA	NA	No	BSL
	193-39-5	Indeno(1,2,3-c,d)pyrene	2,000	2,000	ug/kg	HA-10	1/16	2,000	2,000	NA	100,000	NA	NA	No	BSL
	743-99-21	Lead (5)	2,800	640,000	ug/kg	HA-1	55/57	2,800-640,000	357,521	12,800	900000 (6)	NA	NA	No	BSL
	133-02-07	M-and/or p-xylene	520	520	ug/kg	HA-5	1/16	520	520	NA	700 (7)	NA	NA	No	BSL (7)
	75-09-2	Methylene chloride	28	320	ug/kg	SB-21	23/33	28-320	137	NA	19,000	NA	NA	No	BSL
	133-02-07	O-Xylene	57	190	ug/kg	HA-5	2/16	57-190	190	NA	700 (7)	NA	NA	No	BSL (7)
	85-01-8	Phenanthrene	340	8,700	ug/kg	HA-10	6/16	340-8,700	3,240	NA	5,300	NA	NA	No	BSL
	129-00-0	Pyrene	340	15,000	ug/kg	HA-10	7/16	340-15,000	5,386	NA	480,000	NA	NA	No	BSL
	79-01-6	Trichloroethene	100	100	ug/kg	HA-12	1/16	100	100	NA	4,000	NA	NA	No	BSL
	133-02-07	Xylenes	57	710	ug/kg	HA-14	2/16	57-710	710	NA	700	NA	NA	Yes	ASL
	744-06-66	Zinc	19,000	2,584,000	ug/kg	HA-12	47/47	19,000-2,584,000	8,285,202	36,800	1,000,000,000	NA	NA	No	BSL

(1) For data sets with at least three data points, the minimum of either the 95% UCL or the maximum detected concentration was used as the EPC; for less than three data points, the maximum detected concentration was used as the EPC

(2) Lowest of MDEQ Part 201 Commercial (II) Screening Criteria

(3) Rationale Codes: Selction Codes:

Above Screening Levels (ASL)

Below Screening Levels (BSL)

(4) Per Part 201 Criteria, footnote H, total chromium data is evaluated as Cr VI.

(5) Does not inlcude data associated with Waste Storage Area Number 6; this area will be treated as a hotspot.

(6) Value for lead is a draft value.

(7) Screening Criterial for Total Xylenes were used

TABLE 2.6

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

HENKEL SURFACE TECHNOLOGIES

Scenario Timeframe:	Current and Future
Medium:	Subsurface Soil
Exposure Medium:	Subsurface Soil

Exposure Point	CAS Number	Chemical	Minimum Concentration	Maximum Concentration	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration Used for Screening (1)	Background Value (mg/kg) (2)	Screening Toxicity Value (N/C) (3)	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag (Y/N)	Rationale for Selection or Deletion (4)
Soil	1854-02-99	Chromium VI (5)	3,900	6,200	ug/kg	SB-5	2/2	3,900-6,200	6,200	10,900	3,300	NA	NA	Yes (6)	ASL (6)
	744-05-08	Copper	3,300	6,900	ug/kg	SB-5	2/2	3,300-6,900	6,900	12,000	59,000,000	NA	NA	No	BSL
	743-99-21	Lead (7)	3,200	5,500	ug/kg	SB-5	2/2	3,200-5,500	5,500	6,100	900,000	NA	NA	No	BSL
	75-09-2	Methylene chloride	28	330	ug/kg	SB-21	22/30	28-330	157	NA	19,000	NA	NA	No	BSL
	744-06-66	Zinc	12,200	1,113,000	ug/kg	SB-24	10/10	12,200-1,113,000	669,693	35,600	1,000,000,000	NA	NA	No	BSL

(1) For data sets with at least three data points, the minimum of either the 95% UCL or the maximum detected concentration was used as the EPC; for less than three data points, the maximum detected concentration was used as the EPC

(2) Based on data in Table 2.1f

(3) Lowest of MDEQ Part 201 Commercial (II) Screening Criteria

(4) Rationale Codes:

Above Screening Levels (ASL)

Below Screening Levels (BSL)

(5) Per Part 201 Criteria, footnote H, total chromium data is evaluated as Cr VI.

(6) The minimum, maximum concentration and the average concentration exceed the screening value, and thus Cr VI is carried forth as a COPC.

(7) Does not inlcude data associated with Waste Storage Area Number 6; this area will be treated as a hotspot.

TABLE 2.7

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

HENKEL SURFACE TECHNOLOGIES

Scenario Timeframe:	Current and Future
Medium:	Groundwater
Exposure Medium:	Groundwater

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier) (1) (2)	Maximum Concentration (Qualifier) (1) (2)	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection Limits	Concentration Used for Screening (3)	Screening Toxicity Value (4)	COPC Flag (Y/N)	Rationale for Selection or Deletion (5)
Groundwater	75-34-3	1,1-Dichloroethane	2	3	ug/L	MW-3	2/16	3-Feb	3	2,500	No	BSL
	75-35-4	1,1-Dichloroethene	3 J	7	ug/L	MW-4	7/25	3.0-7	2.9	7	No	BSL
	75-27-4	Bromodichloromethane	1	2	ug/L	MW-1	2/15	1-2	2	100	No	BSL
	67-66-3	Chloroform	1	2	ug/L	MW-1	3/25	1-2	2	100	No	BSL
	156-59-2	Cis-1,2-Dichloroethene	34.5(6)	51.0	ug/L	MW-200	4/10	34.5-51	50.9	70	No	BSL
	156-60-5	Trans-1,2-Dichloroethene	1	13.5 (6)	ug/L	MW-3	2/5	1-13.5	13.5	100	No	BSL
	79-01-6	Trichloroethene	2.8	43	ug/L	MW-3	8/21	2.8-43	14	5	Yes	ASL
	75-69-4	Trichlorofluoromethane	5.4	5.4	ug/L	MW-3	1/5	5.4	5.4	7,300	No	BSL
	71-55-6	1,1,1-Trichoroethane	2	2	ug/L	MW-2	1/15	2-2	2	200	No	BSL
	75-01-4	Vinyl Chloride	19.5	30	ug/L	MW-3	2/5	19.5-30	30	2	Yes (6)	ASL (7)
	7440-38-2	Arsenic	1.4	6	ug/L	MW-4	3/4	1.4-6	6	50	No	BSL
	1854-02-99	Chromium, total	1	5.6	ug/L	MW-1	8/18	1-5.6	5.6	11	No	BSL
	7440-50-8	Copper	6.5	32	ug/L	MW-1	5/18	6.5-32	27	1,000	No	BSL
	7439-92-1	Lead	3.3	110	ug/L	MW-1	6/18	3.3-110	35	NA	No	BSL
	7440-02-0	Nickel	3.1	67.2	ug/L	MW-4	4/4	3.1-67.2	67	100	No	BSL
	7440-68-6	Zinc	7	130	ug/L	MW-2	13/18	7-130	72	5,000	No	BSL

(1) Qualifier "J" indicates an estimated concentration

(2) Duplicates were averaged and considered one sample

(3) For data sets with at least three data points, the minimum of either the 95% UCL or the maximum detected concentration was used as the EPC; for less than three data points, the maximum detected concentration was used as the EPC

(4) Lowest of MDEQ Part 201 Commercial II Criteria fro Groundwater Protection

(5) Rationale Codes: Selction Codes:

Above Screening Levels (ASL)

Below Screening Levels (BSL)

(6) Concentration is average of duplicates

(7) The minimum and maximum values as well as the average value exceed the screening criteria and thus vinyl chloride is carried forth.

TABLE 3.1

SELECTION OF EXPOSURE PATHWAYS

HENKEL SURFACE TECHNOLOGIES

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current and Future	Soil	Soil	Contaminants are in soil and soil is evaluated	Commercial/Industrial Worker II	Adult	Ingestion	On-Site	MDEQ	Worker incidentally ingests soil - exclude
						Dermal Contact	On-Site	MDEQ	Worker contacts soil - exclude
						Airborne particulates	On-Site	MDEQ	Worker inhales airborne particulates from soil - exclude
				Construction Worker	Adult	Ingestion	On-Site	MDEQ	Worker incidentally ingests soil - exclude
						Dermal Contact	On-Site	MDEQ	Worker contacts soil - exclude
						Airborne particulates	On-Site	MDEQ	Worker inhales airborne particulates from soil - exclude
				Trespasser (Assume no fence in place)	Adolescent	Ingestion	On-Site	MDEQ	Trespasser incidentall ingests soil - exclude
						Dermal Contact	On-Site	MDEQ	Trespasser contacts soil - exclude
						Airborne particulates	On-Site	MDEQ	Trespasser inhales airborne particulates from soil - exclude
Future	Groundwater	Groundwater	Contaminants are in groundwater and groundwater is evaluated	Construction Worker	Adult	Ingestion	On-Site	MDEQ/Quantitati	Worker incidentally ingests groundwater - select
						Dermal Contact	On-Site	MDEQ	Worker contacts groundwater - exclude
						Inhalation	On-Site	MDEQ	Worker inhales volatilizing constituents in air - exclude

Notes:

MDEQ - EPC were below MDEQ screening crtierion for the exposure route

Quantitative - EPC did not pass MDEQ screening criterion, selected for analysis

TABLE 3.2

EQUATION FOR INCIDENTAL INGESTION OF GROUNDWATER

HENKEL SURFACE TECHNOLOGIES

$$\text{Intake (Ug/kg-day)} = \frac{Cw \times IRw \times EF \times ED}{BW \times AT}$$

Parameter	Definition	Unit
Intake =	Amount of COPC at exchange boundary	ug/kg-day
Cw =	Chemical Concentration in Groundwater	ug/L
IRw =	Groundwater Ingestion Rate	L/day
EF =	Exposure Frequency	days/year
ED =	Exposure Duration	years
BW =	Body Weight	kg
AT =	Averaging Time	day

Source: EPA, 1989

TABLE 3.3

VALUES USED FOR DAILY INTAKE CALCULATIONS FOR GROUNDWATER

COMMERCIAL/INDUSTRIAL WORKER II

HENKEL SURFACE TECHNOLOGIES

Scenario Timeframe:	Future
Medium:	Groundwater
Exposure Medium:	Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference (1)	Intake Equation/ Model Name (2)
Ingestion	Construction Worker	Adult	Contaminants detected in groundwater	Cw	Chemical Concentration in Groundwater, EPC	Chemical-specific	ug/L	---	Table 3.2
				Irw	Ingestion Rate of Groundwater	0.5	L/day	EPA 2001	Table 3.2
				EF	Exposure Frequency	60	days/year	Professional Judgement (3-month project, 5 days/week)	Table 3.2
				ED	Exposure Duration	1	years	Professional Judgement	Table 3.2
				BW	Body Weight	70	kg	EPA 1991 and 2001	Table 3.2
				AT-C	Averaging Time (Cancer)	25550	days	EPA 1989 and 2001	Table 3.2
				AT-N	Averaging Time (Noncancer)	365	days	EPA 1989 and 2001 (ED x 365 day/yr)	Table 3.2

(1) Source Abbreviations:

EPA, 1989 = Risk Assessment Guidance for Superfund (Part A)

EPA, 1991 = Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Maual Supplemental Guidance

EPA, 2001 = Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites

(2) Table 3.2 - Equation for Incidential Ingestion of Soil

TABLE 4.1

NON-CANCER TOXICITY DATA - ORAL

HENKEL SURFACE TECHNOLOGIES

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Primary Target Organ(s)	RfD:Target Organ(s)	
		Value	Units		Source(s) (1)	Date(s) (MM/DD/YYYY)
Trichloroethene	Chronic	3E-04	mg/kg-day	Liver/Kidney/Neuro	NCEA	04/11/2003
Vinyl Chloride	Chronic	3E-03	mg/kg-day	Liver	IRIS	04/11/2003

(1) Source Abbreviations:

NCEA - National Center for Environmental Assessment

IRIS - Integrated Risk Information System

TABLE 4.2

CANCER TOXICITY DATA - ORAL

HENKEL SURFACE TECHNOLOGIES

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Cancer Slope Factor	
	Value	Unit	Source(s) (1)	Date(s) (MM/DD/YYYY)
Trichloroethene	4.00E-04	1(mg/kg-day)	NCEA	4/11/03
Vinyl Chloride	7.50E-01	1/(mg/kg-day)	IRIS	4/11/03
Vinyl Chloride	2.10E-02	1/(mg/L)	IRIS	4/11/03

(1) Source Abbreviations:

NCEA - National Center for Environmental Assessment

IRIS - Integrated Risk Information System

TABLE 4.2

CANCER TOXICITY DATA - ORAL

HENKEL SURFACE TECHNOLOGIES

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Cancer Slope Factor	
	Value	Unit	Source(s) (1)	Date(s) (MM/DD/YYYY)
Trichloroethene	4.00E-04	1(mg/kg-day)	NCEA	4/11/03
Vinyl Chloride	7.50E-01	1/(mg/kg-day)	IRIS	4/11/03
Vinyl Chloride	2.10E-02	1/(mg/L)	IRIS	4/11/03

(1) Source Abbreviations:

NCEA - National Center for Environmental Assessment

IRIS - Integrated Risk Information System

TABLE 5.1

CALCULATION OF NON-CANER HAZARDS: CONSTRUCTION WORKER

HENKEL SURFACE TECHNOLOGIES

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Receptor: Construction Worker
Receptor Age: Adult

Exposure Route	COPC	EPC Value	EPC Unit	Intake	Intake (units)	RfDo	RfDo Units	Hazard Quotient
Groundwater	Trichloroethene	14	ug/L	1.64E-02	ug/kg-day	3E-07	ug/kg-day	5.48E+04
	Vinyl Chloride	30	ug/L	3.52E-02	ug/kg-day	3E-06	ug/kg-day	1.17E+04
		Total Hazard Index Across All Exposure Routes/Pathways						6.65E+04

TABLE 5.2

CALCULATION OF CANER RISKS: CONSTRUCTION WORKER

HENKEL SURFACE TECHNOLOGIES

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Receptor: Construction Worker
Receptor Age: Adult

Exposure Route	COPC	EPC Value	EPC Unit	Intake	Intake (units)	SFo	SFo Units	Risk
Groundwater	Trichloroethene	14	ug/L	2.35E-04	ug/kg-day	4.0E-01	1/(ug/kg-day)	9.39E-05
	Vinyl Chloride	30	ug/L	5.03E-04	ug/kg-day	7.5E+02	1/(ug/kg-day)	3.77E-01
				Total Risk Across All Exposure Routes/Pathways				3.78E-01

APPENDIX A.1

95% UCL CALCULATION FOR SURFACE SOIL AND DETERMINATION OF EPCS

Attachmetn A.1 Surface Soil UCL and EPC Determination

Surface Soil Data (mg/kg)

Benzo(a)anthracene	0.35	0.33	0.33	0.77	0.33	0.33	0.33	0.33	0.49	6.8	0.5	0.33	0.33	0.33	0.33	0.33
Benzo(a)pyrene	0.33	0.33	0.33	0.87	0.33	0.33	0.33	0.33	0.67	6.1	0.85	0.33	0.33	0.33	0.33	0.33
Benzo(b)fluoranthene	0.42	0.33	0.33	0.91	0.33	0.72	0.33	0.33	1.2	9.6	0.54	0.33	0.33	0.48	0.33	0.33
Benzo(k)fluoranthene	0.36	0.33	0.33	1.2	0.33	0.69	0.33	0.33	0.06	0.1	0.05	0.33	0.33	0.33	0.33	0.33
Chromium (VI)	0.237	0.219	0.217	0.227	0.214	0.23	1.48	0.231	0.228	0.223	1.45	1.74	0.227	4.9	0.223	0.21
	56.5	29.4	5.2	20	27.6	42	101	12.9	34.9	37.1	36.5	102	18.7	231	15.6	5.6
	14	31	340	110	390	29	11	10	12	18	12	15	143	77	52	4.8
	9.2	7.7	11	9	12	8.1	20	30	31	160	19	102	106	115	52	7.1
	7.2	16	17	21												
Chrysene	0.41	0.33	0.33	0.69	0.33	0.4	0.33	0.33	0.51	4.9	0.55	0.33	0.33	0.33	0.33	0.33
Copper	36.1	22	5	64.8	33	308	14.3	8.4	25.2	24.9	18.4	27.1	10.6	64.8	33.4	5.3
	12	15	12	15	12	13	20	8.9	19	22	4.3	7.6	7.7	14	15	29
	10	30	13	35	85	14	58	43	108	570	6.2	6	41	26	6.3	
Fluoranthene	1.2	0.33	0.33	2.5	0.4	1.2	0.33	0.33	1.2	17	1.2	0.33	0.33	0.34	0.38	0.33
Lead (4)	640	25.7	25	87.1	28.7	90.9	10.7	26.1	40.3	183	63.5	324	12.5	246	34.3	25
	60	34	71	46	2400	1000	500	560	82	82	39	23	55	116	22	125
	24	21	55	53	2.8	14	14	38	16	90	14	140	18	74	100	9.6
	203	270	130	240	4.8	6.3	72	120	5.5							
Methylene chloride	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
	64	10	74	10	48	10	200	56	83	28	56	42	200	10	140	10
	62	91	81	42	49	320	320	100	69	83	77	40	52			
Phenanthrene	0.62	0.33	0.33	1.6	0.33	0.55	0.33	0.33	0.34	8.7	0.35	0.33	0.33	0.33	0.33	0.33
Pyrene	0.68	0.33	0.33	1.3	0.33	0.54	0.33	0.33	0.8	15	1.2	0.33	0.33	0.33	0.34	0.33
Zinc	638	342	23.9	752	366	703	144	122	325	568	504	2,584	69.8	1,878	378	34.9
	540	140	153	320	230	340	200	95	670	540	19	95	50	130	41	264
	30	130	270	224	900	51	1700	1400	1160	590	56	1060	1060	740	27	

Chebyshev Inequality - Nonparametric 95%

a = 95%

((1/a) -1)^.5 = 4.358898944

	Mean (u)	s	n	n^.5	s/n^.5	95UCL (mg/kg)	Max (mg/kg)	EPC (mg/kg)	EPC (ug/kg)	MIN (mg/kg)
Benzo(a)anthracene	0.78	1.61	16	4.00	0.40	2.54	6.80	2.54	2536.71	0.33
Benzo(a)pyrene	0.78	1.43	16	4.00	0.36	2.34	6.10	2.34	2338.56	0.33
Benzo(b)fluoranthene	1.05	2.29	16	4.00	0.57	3.55	9.60	3.55	3551.76	0.33
Benzo(k)fluoranthene	0.36	0.27	16	4.00	0.07	0.65	1.20	0.65	652.02	0.05
Chromium (VI)	41.43	72.11	68	8.25	8.74	79.55	390.00	79.55	79548.78	0.21
Chrysene	0.67	1.13	16	4.00	0.28	1.91	4.90	1.91	1906.34	0.33
Copper	42.11	91.43	47	6.86	13.34	100.24	570.00	100.24	100242.67	4.30
Fluoranthene	1.73	4.12	16	4.00	1.03	6.22	17.00	6.22	6218.53	0.33
Lead (4)	154.61	351.45	57	7.55	46.55	357.52	2400.00	357.52	357521.24	2.80
Methylene chloride(1)	54.02	76.26	16	4.00	19.07	137.13	320.00	137.13	137.13	0.25
Phenanthrene	0.97	2.09	16	4.00	0.52	3.24	8.70	3.24	3240.37	0.33
Pyrene	1.43	3.63	16	4.00	0.91	5.39	15.00	5.39	5386.48	0.33
Zinc	482.08	544.89	47	6.86	79.48	828.52	2584.00	828.52	828520.38	19.00

(1) data in units of ug/kg

APPENDIX A.2

95% UCL CALCULATIONS FOR SUBSURFACE SOIL AND DETERMINATION OF EPCS

Attachment A.2 Subsurface Soil UCL and EPC Determination

Subsurface Soil Data (ug/kg)

Methylene Chloride	28	64	38	64	10	62	98	56	46	44
	330	220	220	240	69	130	86	180	10	190
	130	130	10	160	10	10	10	10	10	10
Zinc	16000	33300	403000	30000	93700	1113000	12500	155000	12200	100000

Chebyshev Inequality - Nonparametric 95% (n<25, s=1-1.5) or (n=20-50, s=1.5-2); 99% (n<20,s=1.5-2)

	a = 95%		a = 99%						
	((1/a) -1)^.5 =	4.358898944	((1/a) -1)^.5 =	9.949874371					
	Mean (u)	s	n	n^.5	s/n^.5	95 UCL (ug/kg)	Max (ug/kg)	**EPC (ug/kg)**	MIN (mg/kg)
Methylene Chloride	89.17	85.84	30	5.48	15.67	157.48	330.00	**157.48**	10
Zinc	196870.00	343021.65	10	3.16	108472.97	669692.72	1113000.00	**669692.72**	12.2

APPENDIX A.3

95% UCL CALCULATIONS FOR GROUNDWATER AND DETERMINATION OF EPCS

Attachment A.3 Groundwater UCL and EPC Determination

Groundwater Data (ug/L)

1,1-Dichloroethene	1	1	1	1	1	1	1	1	1			
	1	1	1	3	7	3	1	1	1			
	1.7	1	1	1	3.3	3.4	3					
Chloroform	1	1	1	1	1	5	1	1	1			
	1	1	1	1	1	1	1	1	1			
	2	2	1	1	1	1	1					
Cis-1,2-Dichloroethene	1	1	1	46	1	1	1	50	51	34.5		
Trichloroethene	1	1	2.8	1	3.3	4	3	1	1			
	1	1	1	1	1	24	5	43	3	1	1	1
Arsenic	1	1.6	1.4	6								
Chromium, total	1	1	1	1	50	5.6	5	1.9	50			
	4	1	1.4	50	2.45	50	1.8	1	1			
Copper	1	1	1	1	25	32	15	25	25			
	20	11	25	25	22.5	25	20	6.5	6.5			
Lead	1	1	1	1	3	110	4.7	3	3			
	3	3.3	3.6	3	3	3	3	3.4	6.5			
Nickel	3.1	3.4	33	67.2								
Zinc	20	100	36	22	57	39	130	37	20			
	29	20	63	50	25	7	17	4	4			

Chebyshev Inequality - Nonparametric 95%

a = 95%

((1/a) -1)^.5 = 4.358898944

	Mean (u)	s	n	n^.5	s/n^.5	95 UCL (ug/L)	Max (ug/L)	EPC (ug/L)	MIN (ug/L)
1,1-Dichloroethene	1.70	1.41	25	5	0.281157133	2.92	7.00	2.9	1
Chloroform	1.24	0.83	25	5	0.166132477	1.96	5.00	2.0	1
Cis-1,2-Dichloroethene	18.75	23.33	10	3.16227766	7.376859464	50.90	51	50.9	1
Trichloroethene	4.81	10.07	21	4.582575695	2.197945856	14.39	43	14.4	1
Arsenic	2.50	2.35	4	2	1.173314394	7.61	6	6.0	1
Chromium, total	12.73	20.55	18	4.242640687	4.842947063	33.84	50	33.8	1
Copper	15.97	10.63	18	4.242640687	2.506681341	26.90	32	26.9	1
Lead	8.86	25.28	18	4.242640687	5.958023858	34.83	110	34.8	1
Nickel	26.68	30.44	4	2	15.22001834	93.02	67.2	67.2	3.1
Zinc	37.78	33.11	18	4.242640687	7.803784718	71.79	130	71.8	4

HUMAN HEALTH RISK ASSESSMENT
FOR
HENKEL SURFACE TECHNOLOGIES
MORENCI, MICHIGAN
U.S. EPA ID No. MID058723867

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Receptor, Child

EXECUTIVE SUMMARY

Henkel Surface Technologies (HST) is a chemical specialty products manufacturer that operated in the town of Morenci, Michigan from 1928 until 1988. Dragun Corporation (Dragun) conducted surface soil and groundwater sampling on behalf of HST on September 17 and 18, 2002. Soil samples were collected to characterize potential impacts to soil in the western portion of the site and between the western property fence line and Bean Creek. Groundwater samples were collected from four existing monitoring wells at the site. This risk assessment utilizes the soil and groundwater data generated from the Dragun sampling event, as well as split sampling data collected during that sampling event by the Michigan Department of Environmental Quality (MDEQ).

Nine contaminants of potential concern (COPCs) were identified in surface soil at HST. Benzo(a)pyrene, chromium (VI), dibenz(a,h)anthracene, fluoranthene, lead, phenanthrene, trichloroethene, total xylenes and zinc were detected in surface soil at concentrations which exceeded one or more of the MDEQ Screening Criteria for Residential and Commercial(I) soil. Vinyl chloride was the only COPC identified in groundwater. Vinyl chloride was selected as a COPC because it exceeded drinking water and groundwater/surface water interface MDEQ Screening Criteria for Residential and Industrial-Commercial screening criteria.

Quantitative exposure assessments were performed for the Commercial/Industrial Worker, Construction Worker, Trespasser and Recreational Adult and Child. All identified receptors were evaluated for exposure to COPCs in surface soil. The Construction Worker was additionally evaluated for exposure to vinyl chloride in groundwater. Quantitative estimates of exposure to constituents in surface water and sediment for the Trespasser and Recreational Adult and Child were not possible due to a lack of data collected in these media. Subsurface soil data were also not available. Therefore, the exposure assessment for the Construction Worker is based only on surface soil data.

Estimates of intake developed during the exposure assessment were combined with toxicity criteria (reference doses (RfDs) and cancer slope factors (CSFs)) to obtain estimates of risk and hazard. Lifetime incremental cancer risk estimates for all receptors exceeded the target risk of 1E-06. Exposure to benzo(a)pyrene and dibenz(a,h)anthracene in soil contributed significantly to the total risk. Estimates of noncarcinogenic hazard were less than the target hazard index of 1 for all receptors and all exposure pathways.

SECTION 1.0 INTRODUCTION

Section 1.1 Overview

Henkel Surface Technologies (HST) is a chemical specialty products manufacturer that operated in the town of Morenci, Michigan from 1928 until 1988. Dragun Corporation (Dragun) conducted surface soil and groundwater sampling on behalf of HST on September 17 and 18, 2002. Soil samples were collected to characterize potential impacts to soil in the western portion of the site and between the western property fence line and Bean Creek. Groundwater samples were collected from four existing monitoring wells at the site. This risk assessment utilizes the soil and groundwater data generated from the Dragun sampling event, as well as split sampling data collected during that sampling event by the Michigan Department of Environmental Quality (MDEQ).

Section 1.2 Site Background

HST is located in the town of Morenci, in Lewanee County, Michigan. Facility property encompasses approximately 10 acres, and is located at the west edge of the City of Morenci. Bean Creek borders the facility to the west. The general facility location is depicted in Figure 1.

Section 1.2.1 Site History

Active operations occurred on this site from 1928 until 1988. The facility manufactured chemical specialty products for metal cleaning and treating, metal drawing compounds, lubricants and rust inhibitors, under several owners and/or names, including Oxy Metal Industries Corporation, Hooker Chemicals and Plastics Corporation, Occidental Chemical, Ford Motor Company, Parker Chemical Company, Parker-Anchem, and Henkel Surface Technologies. Parker Chemical Company was acquired by Henkel Corporation in 1988, and began operating at the Morenci, Michigan location as Henkel Surface Technologies.

The facility was inspected by the Michigan Department of Natural Resources (MDNR) (now known as the MDEQ) on several occasions in 1982. During these inspections, MDNR employees noted chemical residues on the ground and indications of overland runoff from a drum storage area to Bean Creek.

Section 1.2.2 Site Description

HST is located in a developed area of the City of Morenci. The facility is bordered on the east and south by commercial/industrial properties, and on the west by Bean Creek. The facility lies in a glacial spillway and outwash deposit which can be traced north to Adrian, Michigan and south into Ohio. The flood plain of Bean Creek, on the facility's west boundary, has been cut into outwash deposits. The Lewanee County Soil Survey depicts the edge of the flood plain as a scarp running through the facility site. Subsurface information indicates the presence of a glacial till proceeding to sand and gravel at a depth of approximately 90 feet, under which is an aquifer of major importance to the Morenci area.

The solid waste management units and areas of concern include seven waste storage areas, labeled as Areas 1 through 7. These Areas are depicted on Figure 2.

Section 1.3 Scope of the Risk Assessment

Based on the results of previous soil and groundwater investigations, this risk assessment focuses on sampling data collected from Areas 2, 5 and 7, as well as from the area west of the facility property line, adjacent to Bean Creek. This assessment of risk includes a description of the chemicals detected at the site, their physical and chemical properties, their toxicological characteristics, and an evaluation of the potential human health risks associated with the presence of these chemicals at the HST facility.

The risk assessment is organized as follows:

- Identification of Chemicals of Potential Concern
- Dose-Response Information
- Exposure Assessment
- Risk Characterization
- Uncertainties
- Summary and Conclusions

SECTION 2.0 IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

Section 2.1 Data Collection Procedures

Dragun conducted surface soil and groundwater sampling on behalf of HST on September 17 and 18, 2002. Soil samples were collected to characterize potential impacts to soil in the western portion of the site and between the western property fence line and Bean Creek. Groundwater samples were collected from four existing monitoring wells at the site. Details regarding sample locations and sampling procedures are provided below.

Section 2.1.1 Soil Sampling

Dragun installed sixteen surface soil borings (HA1 through HA-16) to depths of approximately one foot below ground surface (bgs). Soil sample locations are depicted in Figure 2. Soil samples were field-screened with a photoionization detector (PID) to determine the presence of organic vapors. No PID readings were detected at any of the sample locations. Subsurface soil samples were not collected during this sampling event.

Soil samples were collected using a stainless steel hand scoop, and were deposited into Series 200 ICHEM laboratory containers (or equivalent) using standard U.S. EPA sampling protocols, chain-of-custody documentation and sample shipment procedures. Soil samples collected for volatile organic compound (VOC) analysis were collected using U.S. EPA Method 5035 (methanol preservation) techniques.

Soil samples were submitted to KAR Laboratories, Inc. (KAR) of Kalamazoo, Michigan for the following analyses:

- VOCs (Method 8260)
- Polychlorinated biphenyls (PCBs) (Method 8080)
- Polynuclear aromatic chemicals (PNAs) (Method 8270)
- Metals (hexavalent chromium, total chromium, copper, lead and zinc) (Method 6010B, hexavalent chromium by Method 7196A)

Section 2.1.2 Groundwater Sampling

Dragun sampled groundwater from four existing monitoring wells to evaluate current groundwater quality. Monitoring well locations are depicted in Figure 2.

Screen lengths for the four monitoring wells ranged in length from 10.6 to 23.5 feet. An inflatable packer was installed in each of the wells to limit the well screen exposed to the groundwater to five feet in length. The exposed components of the packer are composed of Buna-N and stainless steel. Each packer was inflated using an air pump, and was positioned in a monitoring well with a stainless steel wire, exposing the upper five feet of the saturated well screen. Temperature, conductivity, Eh and pH measurements were collected following the removal of each well volume. The groundwater sample was collected following stabilization of field chemistry and the removal of at least three well volumes.

Each monitoring well was sampled using a dedicated positive displacement pump. Groundwater samples were collected in Series 200 ICHEM laboratory containers (or equivalent) using U.S. EPA sampling procedures, chain-of-custody documentation and sample shipment procedures.

Groundwater samples were submitted to KAR Laboratories of Kalamazoo, Michigan and analyzed for the presence of VOCs utilizing U.S. EPA Method 8260. One trip blank was prepared and tested for the presence of VOCs utilizing U.S. EPA Method 8260.

Section 2.2 Data Analysis Results

Analytical data summary tables are included as Tables 2.1 and 2.2. Tables 2.5 and 2.6 are the "Occurrence, Distribution and Selection of COPC" tables for the surface soil and groundwater, respectively, and represent the COPC selection results from screening based on a residential scenario. The minimum and maximum concentration locations, the frequencies of detection, and the lowest human health benchmarks are represented. Constituents selected as COPCs are flagged, indicating the benchmarks that were exceeded.

Section 2.2.1 Detected Constituents in Soil

VOCs, semivolatile organic compounds (SVOCs) and metals were detected in surface soil. Five VOCs (1,2,4-trimethylbenzene, m-and/or p-xylene, o-xylene, trichloroethene and xylenes) were detected in three soil samples. Fifteen SVOCs (acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd) pyrene, phenanthrene and pyrene) were detected in eight soil samples. Five metals (hexavalent chromium, total chromium, copper, lead and zinc) were detected in sixteen soil samples.

Analytical results were compared to MDEQ Part 201 Generic Cleanup Criteria and Screening Levels for Residential and Commercial Soil. Results were compared to all screening criteria available for a specific constituent, and the most conservative screening criteria were used. Nine constituents (benzo(a)pyrene, chromium (VI) dibenz(a,h)anthracene, fluoranthene, lead, phenanthrene, trichlorothene, xylenes and zinc) met or exceeded one of the Part 201 screening criteria, and were carried forward into the risk assessment. A summary of soil screening criteria is provided in Table 2.3.

Section 2.2.2 Detected Constituents in Groundwater

Five VOCs were detected in groundwater. These VOCs (1,1-dichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, trichloroethene and vinyl chloride) were detected in monitoring well MW-3. The duplicate sample collected at MW-3 (labeled MW-200) exhibited similar concentrations of the detected constituents.

Analytical results were compared to MDEQ Part 201 Generic Cleanup Criteria and Screening Levels for Residential and Industrial-Commercial Exposure for direct contact, drinking water exposure, groundwater quality that may impact surface water quality, and groundwater contamination risks from indoor air inhalation exposure. Although groundwater-to-air exposures were associated with a construction worker scenario that would likely result in volatilization to ambient air rather than indoor air, use of the indoor air screening criteria is conservative. Volatile constituents in groundwater collecting in buildings would be expected to be more concentrated than those constituents released to and dispersing in ambient air. Therefore, it is expected that the use of the indoor air screening criteria is protective of outdoor exposures. Vinyl chloride was the only constituent that exceeded Part 201 screening criteria, and was carried forward to the risk assessment. A summary of groundwater screening criteria is provided in Table 2.4.

SECTION 3.0 EXPOSURE ASSESSMENT

Section 3.1 Characterization of Exposure Setting

Section 3.1.1 Physical Setting

HST is located in a developed area of the City of Morenci. The facility is bordered on the east and south by commercial/industrial properties, and on the west by Bean Creek. The perimeter of the facility is fenced, except for the boundary of the facility property with Bean Creek. For the purposes of conducting this risk assessment, it is assumed that access to HST property is uncontrolled.

Geologic Setting

The facility is located within the Michigan basin, a large regional geological structure of gently dipping rocks made up of Paleozoic and Mesozoic sedimentary rocks of Cambrian and Jurassic age. Advances of large continental glaciers during Pleistocene time eroded and broke down soil and rocks, redepositing this material as sediments as the glaciers melted and retreated. Most of Michigan is covered by glacial sediments or gravels, sands and clays derived from them. Virtually all of the geographic and topographic features of Michigan were shaped by glacial and melt wash action.

Soil Type

Soil sample boring logs indicate that soil type at the facility is a combination of fine to medium sand, underlain by silty clay and silt.

Location and Description of Surface Water

Bean Creek lies immediately west of the HST facility. A recent groundwater study conducted by Dragun indicates that Bean Creek is a discharge point for groundwater underlying the HST facility.

The potential recreational uses of Bean Creek have not been documented. However, for the purpose of conducting a conservative risk assessment, it has been assumed that Bean Creek is used by adults and children for recreational purposes (fishing and wading) during the summer months (May through September).

Section 3.1.2 Potentially Exposed Populations

The site is currently inactive. Future uses of the property are expected to be industrial. However, due to the uncontrolled site access, it is anticipated that unauthorized persons may enter the site. In addition, it appears that contaminated media near the western edge of HST property may be migrating off-site via airborne particulates and surface runoff to Bean Creek. Based on these assumptions, the following populations are currently expected to be potentially exposed to COPCs originating from the HST facility:

- Commercial/Industrial Worker
- Trespasser

- Recreational Adult and Child

Available information does not indicate that the on-site or surrounding land use will change significantly in the forseeable future. However, to account for possible on-site facility expansion or adjacent off-site residential or industrial growth that would require construction activities, a Construction Worker receptor was evaluated as a potential future receptor. The potential receptors evaluated for a future exposure scenario include:

- Construction Worker
- Commercial/Industrial Worker
- Trespasser
- Recreational Adult and Child

Residential receptors have not been evaluated in this risk assessment. Available information indicates that HST property will be used for industrial or commercial purposes in the foreseeable future. A recent study conducted by Dragun Corporation indicates that groundwater originating from beneath HST property discharges to Bean Creek. Assuming this to be the case, exposure to contaminants in groundwater is not a potential pathway for off-site residents, since groundwater discharging to Bean Creek would be manifested in surface water. An evaluation of exposure to contaminants in surface water is not possible at this time due to a lack of data. Area residents utilizing Bean Creek for recreational purposes will be evaluated as recreational receptors.

Section 3.2 Identification of Exposure Pathways

Section 3.2.1 Sources and Receiving Media

Surface soil at Areas 2, 5 and 7 are contaminated with VOCs, SVOCs and inorganics, as described in Section 2.2. Several constituents in surface soil exceed screening criteria for migration to groundwater. Subsurface soil data is not available; however, groundwater data indicates that constituents have migrated from surface soil to groundwater. Due to the lack of subsurface soil data, it is not known whether subsurface soil is a continuing source of groundwater contamination. In addition, MDEQ site inspection reports (as cited in the Administrative Order) note visual observations of surface runoff from site waste storage areas to Bean Creek, suggesting that surface soil may be a source of contamination for sediments and surface water at Bean Creek.

A recent evaluation of groundwater flow conducted by Dragun Corporation has indicated that groundwater from the facility discharges into Bean Creek. Surface water data has not been collected at Bean Creek to evaluate the potential presence of chemical constituents discharging from groundwater.

Section 3.2.2 Chemical Fate and Transport

Trichloroethene and 1,1-dichloroethene, and their breakdown products, have been detected in both soil and groundwater. Although subsurface data are not available, it appears that constituents historically released to surface soil may have migrated through soil and into groundwater beneath HST property. Several constituents detected in surface soil exceed their respective Part 201 screening criteria for the protection of groundwater. Constituents in groundwater may also migrate to surface water in Bean Creek via groundwater discharge. Finally, constituents in surface soil may also be released as airborne particulates.

Section 3.2.3 Potential Exposure Points and Exposure Routes

Commercial/Industrial Worker

The Commercial/Industrial Worker may contact surface soil during onsite activity. It is anticipated that a commercial/industrial worker will encounter constituents in surface soil through incidental ingestion, dermal contact and inhalation of airborne particulates. It is not anticipated that the Commercial/ Industrial Worker will encounter groundwater, surface water or subsurface soil.

Construction Worker

The Construction Worker, a hypothetical future onsite receptor, may contact surface soil, subsurface soil and groundwater during construction activities. It is anticipated that a construction worker would encounter surface and subsurface soil through incidental ingestion, dermal contact and inhalation of airborne particulates. The construction worker would potentially contact contaminants in groundwater through incidental ingestion, dermal contact and inhalation of volatile constituents. Due to a lack of subsurface soil data, this medium was not quantitatively evaluated for the construction worker. This limitation is discussed in the Uncertainty Assessment.

Trespasser

A Trespasser may contact constituents in onsite surface soil. It is anticipated that a trespasser will encounter constituents in surface soil through incidental ingestion, dermal contact and inhalation of airborne particulates. It is anticipated that trespassers would access HST property through the unfenced, western edge of the property that borders Bean Creek, and would therefore be exposed to constituents in surface water and sediment. Due to a lack of surface water or sediment data, these media were not quantitatively evaluated for the trespasser. This limitation is discussed in the Uncertainty Assessment.

Recreational Receptors

Although information has not been obtained regarding potential recreational activities in the vicinity of the HST facility, it has been assumed that Bean Creek is used for recreational purposes by adults and children on an intermittent basis. Since surface water and sediment data is not available, these media were not quantitatively evaluated. This limitation is discussed in the Uncertainty Assessment. Constituents at concentrations greater than screening level values have been detected in surface soil at sampling locations located outside of HST property, and adjacent to Bean Creek. Therefore, recreational receptors were also evaluated for direct contact with contaminants in surface soil via ingestion, dermal contact and inhalation of airborne particulates.

Section 3.2.4 Complete Exposure Pathways Evaluated in the Risk Assessment

Ingestion of and dermal contact with contaminants in surface soil are considered to be potentially complete exposure pathways for commercial/industrial workers, construction workers, trespassers and recreational receptors. The inhalation of airborne particulates by commercial/industrial workers, construction workers, trespassers and recreational receptors is also considered to be a potentially complete exposure pathway. However, maximum detected concentrations of COPCs in surface soil do not exceed MDEQ Particulate Soil Inhalation Criteria for Residential and Commercial (I) Soil. Therefore, the inhalation of airborne particulates was eliminated as a pathway of concern, and was not quantitatively evaluated.

In addition, the ingestion, dermal contact and inhalation of contaminants in groundwater are considered to be potentially complete exposure pathways for the construction worker. However, maximum detected concentrations of COPCs do not exceed MDEQ Residential and Industrial-Commercial (I) Screening Criteria for direct contact with groundwater or volatilization from groundwater to indoor air. Therefore, dermal contact with groundwater and inhalation of contaminants in groundwater were eliminated as pathways of concern and were not quantitatively evaluated. As discussed in Section 2.2.2, the use of screening criteria for volatilization of contaminants from groundwater to indoor air is expected to be adequately conservative, and is used due to the lack of MDEQ screening criteria for direct inhalation of volatile constituents in groundwater.

Section 3.3 Quantification of Exposure

Section 3.3.1 Determination of Exposure Point Concentrations

As depicted in Table 2.6, vinyl chloride was the only COPC in groundwater. However, the maximum detected concentration of vinyl chloride (30 ug/L) did not exceed MDEQ Residential and Industrial-Commercial (I) Screening Criteria for direct contact (570 ug/L) or volatilization to indoor air (110 ug/L). The maximum detected concentration did exceed all MDEQ residential and commercial drinking water criteria. Although the Construction Worker is not expected to ingest groundwater at the same rate as a receptor using groundwater as a source of drinking water, the Construction Worker was quantitatively evaluated for exposure to vinyl chloride in groundwater through incidental ingestion. The maximum detected concentration was used as the exposure point concentration for this evaluation.

As depicted in Table 2.5, benzo(a)pyrene, chromium (VI), dibenz(a,h)anthracene, fluoranthene, lead, phenanthrene, trichloroethylene, xylenes and zinc were determined to be COPCs in surface soil. Maximum detected concentrations were used as exposure point concentrations for COPCs in surface soil.

Section 3.3.2 Calculating Chemical Intake

Chemical intake was estimated for each potential receptor for both soil and groundwater. Intake was calculated using the maximum detected concentration of each constituent in surface soil or groundwater. Due to the lack of data for constituents in subsurface soil, surface water or sediment, it was not possible to quantitatively estimate intake in these media. This is discussed in the Uncertainty Analysis.

Noncarcinogenic intake was estimated using an average daily exposure. Carcinogenic intakes are calculated as an incremental lifetime average daily exposure, based on a life expectancy of 70 years. Specific equations and input parameters are provided in Tables 3.2 through 3.9. In addition, site-specific exposure parameters are discussed in the following section. Intake estimation spreadsheets are included as an appendix to this risk assessment as support documentation.

Section 3.3.3 Site Specific Exposure Parameters

Default exposure parameters were obtained from current U.S. EPA guidance, including RAGS (1989, 2001), Supplemental Soil Screening Guidance (2001) and the Exposure Factors Handbook (1997).

Commercial/Industrial Worker

The Commercial/Industrial Worker is assumed to be a current or future receptor, potentially exposed to contaminants in surface soil through incidental ingestion, dermal contact and inhalation of airborne soil particulates. The Commercial/Industrial worker was assumed to be an outdoor worker, involved in utility maintenance or groundskeeping activities.

Exposure parameter values were obtained from RAGS (1989, 2001) or SSG (2001). No exposure parameter values were estimated by relying solely on professional judgement. The Commercial/ Industrial worker was assumed to work on-site for 225 days/year, for a duration of 25 years (SSG, 2001). The Commercial/Industrial worker was assumed to have a soil ingestion rate of 100 mg/day, an exposed skin surface area of 3300 square centimeters (cm^2) and a skin-to-soil adherence factor of 0.2 mg/cm^2-event (SSG, 2001). Table 3.7 summarizes all parameter assumptions for the Commercial/Industrial Worker used in the risk assessment.

Construction Worker

The Construction Worker is assumed to be a future receptor, potentially exposed to contaminants in surface and subsurface soil through incidental ingestion, dermal contact and inhalation of airborne soil particulates, as well as to contaminants in groundwater through incidental ingestion, dermal contact and inhalation of volatile constituents.

Exposure parameter values were obtained from RAGS (1989, 2001) or Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (SSG) (2001). No exposure parameters were estimated by relying solely on professional judgement. The Construction Worker was assumed to work on-site for 250 days/year, for a duration of one year (SSG, 2001). The Construction worker was assumed to have a soil ingestion rate of 330 mg/day, an exposed skin surface area of 3300 cm^2 and a skin-to-soil adherence factor of 0.3 mg/cm^2-event (SSG, 2001). In addition, the Construction worker was assumed to have a groundwater ingestion rate of 0.5 liters/day (L/day). Tables 3.5 and 3.6 summarize all parameter assumptions for the Construction Worker used in the risk assessment.

Trespasser

The Trespasser is assumed to be an adolescent who accesses the site on a semi-frequent basis through the unfenced western property boundary. Trespassers would likely be exposed to contaminants in surface soil through incidental ingestion, dermal contact and inhalation of airborne soil particulates, as well as to contaminants in surface water and sediment in Bean Creek. Since surface water and sediment data are not available, trespassers were only evaluated for exposure to constituents in surface soil.

Exposure parameter values were obtained from the Exposure Factors Handbook (EFH), and are based on the assumption that trespassers are adolescents between the ages of 12 and 17. Trespassers are assumed to access the site for a period of 6 years (between the ages of 12 and 17). Trespassers are assumed to access the site one time per week during the months of May through September, for a total of 20 visits per year. This exposure frequency is based on conservative professional judgement given the general weather patterns for southern Michigan (May through September are months during which weather is generally clement enough to expect outdoor activity). Each visit was estimated to last four hours based on conservative professional judgment. A body weight of 56 kilograms was assumed for the trespasser. This value is the average of the 50th percentile values for the weight of adolescents between the ages of 12 and 17, as presented in the EFH.

In order to provide a conservative estimate of exposure, trespassers were assumed to wear short pants and sleeves while on-site. A surface area of 3100 cm^2 and an adherence factor of 0.2 mg/cm^2 were selected based on data presented in the EFH and on conservative professional judgment.

Recreational Receptor - Adult

The Adult Recreational Receptor is assumed to use Bean Creek and the surrounding area on a semi-frequent basis for the purpose of fishing and/or wading. During these activities, Recreational Receptors are assumed to contact surface water, sediment and surface soil. Although a quantitative evaluation of exposure to surface water and sediment was not possible due to a lack of data for these media, a quantitative evaluation was performed for exposure to contaminants in surface soil. The Adult Recreational Receptor was assumed to access Bean Creek for recreational purposes one time per week during the months of May through September, for a total of 20 visits per year. Each visit was estimated to last four hours. These values were estimated using professional judgement based on general weather patterns for southern Michigan (May through September are months during which weather is generally clement enough to expect outdoor recreation). The Adult Recreational Receptor was assumed to access Bean Creek for this purpose for approximately 30 years. This value is the default exposure duration for residential receptors presented in RAGS (1989), and is based on the assumption that Recreational Receptors are nearby residents.

In order to provide a conservative estimate of exposure, the Adult Recreational Receptor was assumed to wear short pants and sleeves during recreational activities. Based on recommendations in RAGS Part E (2001), a surface area of 5700 cm^2 and an adherence factor of 0.07 mg/cm^2 were selected. Table 3.9 summarizes all parameter assumptions for the Adult Recreational Receptor used in the risk assessment.

Recreational Receptor - Child

The Child Recreational Receptor is assumed to use Bean Creek and the surrounding area on a semi-frequent basis for the purpose of fishing and/or wading. A Child Recreational Receptor was assumed to be between the ages of 1 and 6 years old, to have a body weight of 15 kilograms, and to use the Bean Creek area for recreational purposes for six years. The Child Recreational Receptor was assumed to access Bean Creek for this purpose one time per week during the months of May through September, for a total of approximately 20 visits per year. Each visit was estimated to last approximately four hours. These values were estimated using professional judgement based on general weather patterns for southern Michigan (May through September are months during which weather is generally clement enough to expect outdoor recreation).

In order to provide a conservative estimate of exposure, the Child Recreational Receptor was assumed to wear short pants and sleeves during recreational activities. Based on recommendations in RAGS Part E (2001), a surface area of 2800 cm^2 and an adherence factor of 0.2 mg/cm^2 were selected. Table 3.9 summarizes all parameter assumptions used for the Child Recreational Receptor in the risk assessment.

Section 3.4 Summary of Exposure Assessment

Quantitative exposure assessments were performed for the Commercial/Industrial Worker, Construction Worker, Trespasser and Recreational Adult and Child. All identified receptors were evaluated for exposure to constituents in surface soil. The Construction Worker was additionally evaluated for exposure to constituents in groundwater. Quantitative estimates of exposure to constituents in surface water and sediment for the Trespasser and Recreational Adult and Child were not possible due to a lack of data collected in these media.

SECTION 4.0 TOXICITY ASSESSMENT

Toxicity information was obtained from the following sources:

- U.S. EPA's Integrated Risk Information System (IRIS)
- Health Effects Assessment Summary Tables (HEAST)
- National Center for Environmental Assessment (NCEA) Superfund Health Risk Technical Support Center

IRIS was used as the primary information source for toxicological values. When a value was not available in the IRIS database, secondary sources were used to obtain toxicological values.

Section 4.1 Toxicity Information for Noncarcinogenic Effects

Chronic oral Reference Doses (RfDs) or chronic Reference Concentrations (RfCs) were used as the primary criteria for evaluating noncarcinogenic effects. Chronic RfDs and RfCs are estimates of daily exposure doses or concentrations for the human population, including sensitive sub-populations, that are likely to be without an appreciable risk of adverse effects during a lifetime of exposure. RfDs and RfCs are presented in Tables 4.1 and 4.2.

Section 4.2 Toxicity Information for Carcinogenic Effects

Carcinogens are considered to lack a threshold of no adverse effects; this implies that any level of exposure carries some risk. Cancer slope factors (CSFs) have been derived to estimate risks resulting from oral and dermal exposures based on this assumption. A CSF is equal to the slope of the dose-response curve and, when multiplied by the dose, provides an estimate of the upper 95% confidence interval of the incremental lifetime cancer risk, or the probability of cancer occurring above normal background rates. Similarly, inhalation Unit Risks have been developed based on CSFs or derived from inhalation studies to evaluate cancer risks resulting from inhalation exposures. CSFs and inhalation unit risks for COPCs are presented in Table 4.3 and 4.4.

Section 4.3 Lead as a COPC

Lead was initially identified as a COPC for surface soil because the maximum detected concentration (640 mg/kg) exceeds the 400 mg/kg soil screening level for residential/commercial soil. The maximum detected concentration, and the only exceedance of the screening level criteria, was detected at HA-1, between HST property and Bean Creek near Area 6. The average lead concentration in other surface soil samples collected at the site is 90.22 mg/kg, which is less than the 400 mg/kg screening level.

Published toxicity criteria (CSFs, RfDs) are not currently available for lead. U.S. EPA recommends that environmental lead exposures be evaluated using the Integrated Exposure Uptake Biokinetic Model (IEUBK) (U.S. EPA, 1994) for children, and the Adult Lead Model (ALM) (U.S. EPA 1996) for industrial exposures to adult receptors. Both of these guidance documents recommend using the average concentration to evaluate exposure to lead. The average lead concentration in surface soil is 129.49 mg/kg, which is significantly less than the soil concentration of 400 mg/kg at which exposure to lead is expected to result in adverse health effects. Therefore, lead was eliminated as a COPC on the basis of this analysis.

SECTION 5.0 RISK CHARACTERIZATION

Risk characterization represents the final step in the risk assessment process. In this step, the results of the exposure and toxicity assessments are integrated into quantitative or qualitative estimates of potential health risks. Potential noncarcinogenic health effects and carcinogenic health risks are calculated separately.

Potential adverse noncarcinogenic health effects were evaluated using the hazard index (HI). The first step in calculating the HI is to compare the average daily intake dose for each chemical to the appropriate RfD. This comparison is expressed as a hazard quotient (HQ), which is calculated as follows:

$$HQ = \frac{\text{Average Daily Dose}}{\text{RfD}}$$

A HQ of less than or equal to 1 indicates that the predicted exposure to that chemical should not result in an adverse noncarcinogenic health effect. In cases where individual chemicals potentially act on the same organs or result in the same health endpoint (e.g., liver effects, respiratory irritants, etc.), potential additive effects may be addressed by calculating a HI as follows:

$$HI = \quad HQ$$

A HQ of less than or equal to 1 indicates acceptable levels of exposure for chemicals having an additive effect. In this risk assessment, a screening-level HI was calculated by adding the HQs for all chemicals, regardless of toxic endpoint. This approach is generally believed to overestimate the potential for noncarcinogenic health effects due to simultaneous exposure to multiple chemicals because it does not account for different toxic endpoints. However, it can be used as a screening tool to rapidly identify those exposure scenarios for which exposure to multiple chemicals does not pose a carcinogenic risk.

Carcinogenic health risks are defined in terms of the increased probability of an individual developing cancer as the result of exposure to a given chemical at a given concentration. Lifetime excess cancer risks are estimated for any chemical as follows:

$$\text{Lifetime Excess Cancer Risk} = \text{Lifetime Average Daily Dose} \times \text{CSF}$$

As with HIs, the estimated excess cancer risks for each chemical and exposure route are added regardless of toxic endpoint to estimate the total excess cancer risk for the exposed individual.

Estimates of lifetime excess cancer risk associated with exposure to chemicals of less than one in one million (1E-06) area considered low. Cancer risks in excess of the target of 1E-06 may warrant further investigation or analysis.

Section 5.1 Quantifying Risks

Section 5.1.1 Calculating Risks for Individual Substances

Cancer risk and non-carcinogenic hazard estimates were calculated for individual COPCs, using equations presented in RAGS (1989), SSG (2001) and RAGS (Part E, Supplemental Guidance for Dermal Risk Assessment, Interim) (2001). These equations are summarized in Tables 3.2, 3.3 and 3.4. Parameter values used for each of the exposure receptors are summarized in Tables 3.5 through 3.9. Exposure point concentrations used in the risk assessment are maximum detected concentrations, and are summarized in Tables 2.2 and 2.3. Calculation results are presented in Tables 5.1 through 5.5, and are discussed below.

Construction Worker

As summarized in Table 5.1, exposure to benzo(a)pyrene and dibenzo(a,h)anthracene result in an elevated lifetime incremental cancer risk for the construction worker in soil. Total risk due to exposure to benzo(a)pyrene in soil, both from ingestion exposure, is 2.16E-06, and total risk due to dermal exposure is 2.6E-06. Total risk from dibenz(a,h)anthracene due to ingestion is 8.4E-07, and total risk due to dermal exposure is 1.1E-06. There are no COPCs which have an individual HQ greater than the target HQ of 1.

Exposure to vinyl chloride, the only COPC in groundwater, does not result in elevated lifetime incremental cancer risk or noncarcinogenic hazard.

Commercial/Industrial Worker

Exposure to benzo(a)pyrene and dibenz(a,h)anthraceneis result in an elevated lifetime incremental cancer risk for the commercial/industrial worker during exposure to contaminants in soil. Total risk due to ingestion of benzo(a)pyrene in soil is 1.49E-05, and the risk due to dermal absorption of benzo(a)pyrene is 3.9E-05. Total risk due to ingestion of dibenz(a,h)anthracene is 5.E-06, and total risk due to dermal absorption is 1.6E-05. There are no COPCs which have an individual HQ greater than the target HQ of 1.

Trespasser

Estimation of risk and hazard from individual COPCs did not result in adverse risk or hazard estimates for the Trespasser.

Recreational Adult

Exposure to benzo(a)pyrene and dibenz(a,h)anthracene result in an individual risk for the recreational adult receptor. Benzo(a)pyrene has a risk of 1.2E-06 for the soil ingestion pathway, and a risk of 3.3E-06 for the dermal absorption pathway. Exposure to dibenz(a,h)anthracene results in a risk of 1.1E-06 for the ingestion pathway, and a risk of 1.3 E-06 for the dermal absorption pathway. There are no COPCs which have a HQ greater than the target HQ of 1.

Recreational Child

Exposure to benzo(a)pyrene and dibenz(a,h)anthracene both contribute to the total risk for the recreational child receptor. Exposure to benzo(a)pyrene results in a risk of 2.8E-06 for the soil ingestion pathway, and a risk of 3.3E-06 for the dermal absorption pathway. Exposure to dibenz(a,h)anthracene results in a risk of 1.1E-06 for the ingestion pathway and a risk of 1.3E-06 for the dermal absorption pathway. There are no COPCs which have a HQ greater than the target HQ of 1.

Section 5.1.2 Calculating Risks from Multiple Substances

Total risk or hazard for each pathway was calculated by adding the risk or hazard values for individual COPCs.

Construction Worker

The total risk from soil exposure via ingestion is 2.9E-06. This value is driven by exposure to benzo(a)pyrene and dibenz(a,h)anthracene. The total risk from soil exposure via dermal absorption is 3.6E-06, also driven by exposure to benzo(a)pyrene and dibenz(a,h)anthracene. HIs for ingestion and dermal pathways do not exceed the target index of 1. Noncarcinogenic hazard from soil exposure via ingestion is 3.4E-02. Noncarcinogenic hazard from dermal soil exposure is 1.7E-03.

Commercial/Industrial Worker

The total risk from soil exposure via ingestion is 2.0E-05. This value is driven by exposure to benzo(a)pyrene and dibenz(a,h)anthracene. The total risk from soil exposure via dermal absorption is 3.9E-05, also driven by exposure to benzo(a)pyrene and dibenz(a,h)anthracene. HIs for ingestion and dermal pathways do not exceed the target HI of 1. Noncarcinogenic hazard from soil exposure via ingestion is 9.4E-03. Noncarcinogenic hazard from dermal soil exposure is 2.5E-05.

Trespasser

The total risk from soil exposure via ingestion is 3.9E-07. The total risk from soil exposure via dermal absorption is 1.4E-06, influenced by exposure to benzo(a)pyrene and dibenz(a,h)anthracene. The individual risk estimates for these constituents are 9.7E-07 and 4.0E-

07, respectively. HIs for ingestion and dermal pathways do not exceed the target HI of 1. Noncarcinogenic hazard from soil exposure via ingestion is 1.6E-03. Noncarcinogenic hazard from dermal exposure is 1.1E-04.

Recreational Adult

The total risk from soil exposure via ingestion is 3.9E-06. This value is driven by exposure to benzo(a)pyrene and dibenz(a,h)anthracene. The total risk from soil exposure via dermal absorption is 4.6E-06, also driven by exposure to benzo(a)pyrene and dibenz(a,h)anthracene. HIs for ingestion and dermal exposure pathways do not exceed the target HI of 1. Noncarcinogenic hazard from soil exposure via ingestion is 7.8E-03. Noncarcinogenic hazard from soil exposure via dermal absorption is 3.6E-04.

Recreational Child

The total risk from soil exposure via ingestion is 3.9E-06. This value is driven by exposure to benzo(a)pyrene and dibenz(a,h)anthracene. The total risk from soil exposure via dermal absorption is 4.6E-06, also driven by exposure to benzo(a)pyrene and dibenz(a,h)anthracene. HIs for ingestion and dermal exposure pathways do not exceed the target HI of 1. Noncarcinogenic hazard from soil exposure via ingestion is 7.8E-03. Noncarcinogenic hazard from soil exposure via dermal absorption is 3.6E-04.

Section 5.2 Combining Risks Across Exposure Pathways

After combining risks from individual COPCs for each pathway, total risk for each receptor was calculated by adding exposure pathway risks.

Construction Worker

The total lifetime incremental cancer risk for the Construction Worker is 6.5E-06. This risk estimate exceeds the target risk of 1E-06, and is driven by exposure to benzo(a)pyrene and dibenz(a,h)anthracene in soil. The total noncarcinogenic HI for the Construction Worker is 3.6E-02. This value is less than the target HI of 1.

Commercial/Industrial Worker

The total lifetime incremental cancer risk for the Commercial/Industrial Worker is 5.9E-05. This risk estimate exceeds the target risk of 1E-06, and is driven by exposure to benzo(a)pyrene and dibenz(a,h)anthracene, through incidental ingestion and dermal exposure. The total noncarcinogenic HI for the Commercial/Industrial Worker is 9.4E-03. This value is less than the target HI of 1.

Trespasser

The total lifetime incremental cancer risk for the Trespasser is 1.8E-06. This risk estimate exceeds the target risk of 1E-06, and is driven by dermal exposure to benzo(a)pyrene and dibenz(a,h)anthracene. Estimates of risk calculated for individual COPCs did not result in values greater than 1E-06. The total noncarcinogenic HI for the Trespasser is 1.7E-03. This value is less than the target HI of 1.

Recreational Adult

The total lifetime incremental cancer risk for the Recreational Adult is 8.5E-06. This risk estimate exceeds the target risk of 1E-06, and is driven by exposure to benzo(a)pyrene and dibenz(a,h)anthracene, through incidental ingestion and dermal exposure. The total non-carcinogenic HI for the Recreational Adult is 8.1E-03. This value is less than the target HI of 1.

Recreational Child

The total lifetime incremental cancer risk for the Recreational Child is 8.5E-06. This risk estimate exceeds the target risk of 1E-06, and is driven by exposure to benzo(a)pyrene and dibenz(a,h)anthracene, through incidental ingestion and dermal exposure. The total non-carcinogenic HI for the Recreational Child is 8.2E-03. This value is less than the target HI of 1.

Section 5.3 Summary of Risk Characterization

Estimates of lifetime incremental cancer risk exceeded the target risk of 1E-06 for all receptors. This exceedance is a result of exposure to benzo(a)pyrene and dibenz(a,h)anthracene in surface soil. Exposure to benzo(a)pyrene and dibenz(a,h)anthracene through the ingestion pathway contributed most significantly to estimates of total cancer risk. Estimates of noncarcinogenic hazard were less than the target HI of 1 for all receptors.

SECTION 6.0 UNCERTAINTY ANALYSIS

Section 6.1 Data Evaluation and Selection of Contaminants of Potential Concern

The selection of site-related COPCs was based on the results of the sampling and analytical program established at the site. Although problems with the data or sample collection procedures were not identified in available information, factors such as appropriate sample locations, adequate sample quantities, laboratory analyses and data validation can contribute to uncertainty with regard to data, and may contribute to an under- or overestimation of risk and hazard. The lack of surface water, sediment and subsurface soil data has resulted in an incomplete quantitative analysis of risk and hazard for the Construction Worker and Recreational Receptors.

Section 6.2 Exposure Assessment

Several areas of uncertainty should be considered with regard to the exposure assessment. Exposure parameters for the recreational and trespasser receptors were based on professional judgement, relying on guidance whenever possible. However, assumptions made about trespassing activity and recreational use of Bean Creek may overestimate or underestimate actual activity patterns.

The lack of data for certain media also affects the exposure assessment. Data are not available which measure the potential presence and concentration of constituents in surface water, sediment or subsurface soil. It is assumed that recreational receptors may use Bean Creek for fishing and/or wading, and may be exposed to COPCs in the surface water and sediment of Bean Creek. A recent study conducted by Dragun Corporation indicates that groundwater that originates beneath the HST facility discharges into Bean Creek. Since COPCs have been detected in groundwater, it is reasonable to assume that these COPCs may be present at some concentration in Bean Creek. In addition, historical investigation reports written by MDEQ personnel note that surface runoff of chemicals into Bean Creek was observed, originating from areas of concern on HST property. Due to the lack of surface water and sediment data, a quantitative analysis of exposure to COPCs in these media was not possible. Therefore, the actual exposure of trespassers and recreational receptors may be underestimated.

Construction workers were evaluated as a potential future receptor. However, subsurface soil data were not available. Since construction activities are usually assumed to extend into the subsurface soil, construction workers can reasonably be assumed to contact any COPCs in subsurface soil. Due to the lack of subsurface soil data, a qualitative analysis of exposure to COPCs in subsurface soil was not possible. All Construction Worker soil exposures were assumed to involved surface soil only. Since it is not known how the surface soil constituent concentrations may change with depth, the actual exposure of Construction Workers may be overestimated or underestimated.

Finally, maximum detected concentrations were used as exposure point concentrations. Since it is unlikely that receptors will consistently be exposed to the maximum detected concentrations of COPCs, use of these values as exposure point concentrations is likely to overestimate actual exposure of all receptors to COPCs in soil and groundwater.

Section 6.3 Toxicity Assessment

Toxicity values are not available for several constituents. For this reason, it was not possible to quantitatively evaluate risk and hazard due to exposure to these chemicals in soil. Specifically, toxicity values are not published for phenanthrene. In addition, RAGS Part E does not support the use of dermal absorption factors for many constituents. At this time, the only COPCs for which dermal absorption factors are supported are benzo(a)pyrene, dibenz(a,h)anthracene and fluoranthene. The lack of a quantitative analysis which includes these constituents may underestimate potential risk and hazard.

Section 6.4 Uncertainty Associated with Risk Characterization

Maximum detected concentrations of detected chemicals were compared to Michigan Department of Environmental Quality (MDEQ) Part 201 Screening Criteria. Chemicals were initially screened against the most conservative screening criteria for soil or groundwater, and if the maximum detected concentration exceeded any of the screening criteria, that chemical was considered to be a contaminant of potential concern (COPC). During the exposure assessment, maximum detected concentrations of COPCs were compared to pathway-specific Part 201 Screening Criteria to determine whether the potential effects of a COPC should be quantitatively evaluated for a potential exposure pathway. For example, vinyl chloride was selected as a COPC for groundwater, based on its exceedance of screening criteria for drinking water. However, the maximum detected concentration of vinyl chloride was less than the screening criterion for direct contact in groundwater, so vinyl chloride was not quantitatively evaluated for the dermal absorption pathway.

The use of the Michigan Part 201 Screening Criteria relies on a compartmentalized assessment approach which allows for the identification of COPCs based on comparison to individual pathway-specific levels (for example, a single residential soil criterion based on dermal contact). The overall risks subsequently estimated using the Michigan criteria consider only those pathways initially identified as posing potentially significant risk. In contrast, typical U.S. EPA screening criteria (e.g., Region 9 PRGs) are based on a spectrum of exposure pathways. For example, the Region 9 PRG for residential soils is reflective of soil ingestion, dermal contact, and inhalation of airborne particulates/volatiles. In addition, once COPCs are selected using U.S. EPA screening criteria, the risks subsequently estimated following U.S. EPA's combined cumulative approach consider all complete exposure pathways. In spite of this fundamental difference, it is likely that those contaminants which contribute most significantly to the overall estimates of risk and hazard (risk drivers) in the risk assessment itself have been identified as site COPCs using the Michigan Part 201 Screening Criteria approach.

SECTION 7.0 SUMMARY AND CONCLUSIONS

Nine COPCs were identified in surface soil at HST. Benzo(a)pyrene, dibenz(a,h)anthracene, hexavalent chromium, fluoranthene, lead, phenanthrene, total xylenes and zinc were detected in surface soil at concentrations which exceeded one or more of the MDEQ Screening Criteria for Residential and Commercial (I) soil. Vinyl chloride was the only COPC identified in groundwater. Vinyl chloride was selected as a COPC because it exceeded drinking water and groundwater/surface water interface MDEQ Screening Criteria for Residential and Industrial-Commercial screening criteria.

Quantitative exposure assessments were performed for the Commercial/Industrial Worker, Construction Worker, Trespasser and Recreational Adult and Child. All identified receptors were evaluated for exposure to COPCs in surface soil. The Construction Worker was additionally evaluated for exposure to vinyl chloride in groundwater. Quantitative estimates of exposure to constituents in surface water and sediment for the Trespasser and Recreational Adult and Child were not possible due to a lack of data collected in these media. Subsurface soil data were also not available. Therefore, the exposure assessment for the Construction Worker is based only on surface soil data.

Estimates of intake developed during the exposure assessment were modified with toxicity criteria (RfDs and CSFs) to obtain estimates of risk and hazard. Lifetime incremental cancer risk estimates for all receptors exceeded the target risk of 1E-06. Exposure to benzo(a)pyrene and dibenz(a,h)anthracene in soil, especially via dermal absorption, contributed significantly to the total risk. Estimates of noncarcinogenic hazard were less than the target hazard index of 1 for all receptors and all exposure pathways.

The results of the risk assessment suggest that further investigation of the site may be warranted to better identify the nature and extent of contaminants that may be present at concentrations not protective of human health.

SECTION 8.0 REFERENCES

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